Popular Science Monthly

Most Wonderfully Illustrated Magazine in the World

SEPTEMBER, 1924; Vol. 105, No. 3
25 cents a Copy; $2.50 a Year

Published in New York City at
250 Fourth Avenue

Coming Next Month

How to light your home scientifically. Did you know that color, like music, has the power to stimulate or depress you, to make you gay or sad, to disturb or refresh you? In an extraordinary article in next month's POPULAR SCIENCE MONTHLY, a lighting expert reveals astonishing facts about light and color and their important effects on your health, comfort, and happiness.

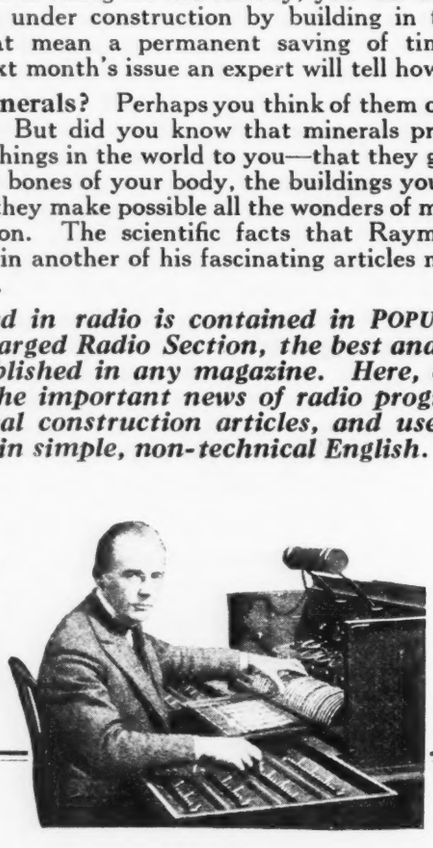
Are there twins in your family, or among your acquaintances? If so, you will be interested in an article by Dr. H. H. Newman, Professor of Zoology and Embryology at the University of Chicago. From scientific research, he explains in plain words the mysteries of multiple birth that have puzzled and fascinated men and women for centuries. One of the most enlightening discussions of the subject ever published.

This is the day of the mechanical housemaid. What the efficiency engineer is doing for the factory, you can do for your new home while it is under construction by building in the mechanical conveniences that mean a permanent saving of time, labor, and drudgery. In next month's issue an expert will tell how to do it.

What are minerals? Perhaps you think of them only as ores and precious metals. But did you know that minerals probably are the most important things in the world to you—that they go into the food you eat, the very bones of your body, the buildings you live and work in—in fact, that they make possible all the wonders of modern industry and transportation. The scientific facts that Raymond J. Brown tells about them in another of his fascinating articles next month will truly amaze you.

The last word in radio is contained in POPULAR SCIENCE MONTHLY'S enlarged Radio Section, the best and most useful of its kind published in any magazine. Here, every month, you will find the important news of radio progress in all its phases, practical construction articles, and useful hints for everybody—all in simple, non-technical English.

Thomas Wilfred, musician and inventor, at the keyboard of the organ with which he plays pleasing symphonies of light on a screen, just as a musician would play music. The instrument blends color in infinite combinations and effects



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H. J. Fisher, *President;* R. C. Wilson, *Vice-President;* O. B. Capen, *Secretary and Treasurer*

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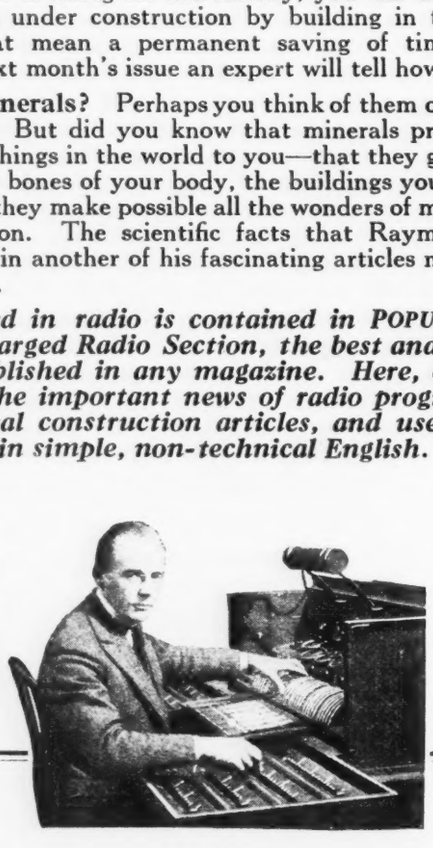

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And other timely articles and pictures

NOW FREE!

The Book That Has Shown Thousands the Way to Amazing Salary Increases

TAKE this situation. A man who had worked all his life in a routine job at low pay suddenly surprises his friends by moving into a better neighborhood, taking a big house, buying a car and blossoming out as a well-to-do and influential citizen in his new community. How did he do it? What is the secret that he used? Simple enough. He knew that the biggest money in business is in selling, and though he felt that he couldn't sell a thing he learned the secrets that make Master Salesmen, and then began to make big money.

If only one man had found inspiration enough in this remarkable book to make a brilliant success in the Selling field—in a job paying him many times his former salary—then you might call it luck. But thousands have done it.

READ!

Charles Berry, of Winterset, Ia., stepped from $18 a week as a clerk to a position making him $1,000 the very first month. J. P. Overstreet, of Denison, Tex., read this book, left a job on the Capitol Police Force, and in six weeks earned $1,800. F. Wynn, Portland, Ore., an ex-service man, earned $554.37 in one week. George W. Kearns, of Oklahoma City, found in this book a way to jump his earnings from $60 a month to $524.00 in two weeks, and C. W. Campbell learned from it how he could quit a clerking job on the railroad to earn $1,632 in thirty days.

Your One Chance to Make the Biggest Money of Your Life

Not one of the men whose names appear above had ever sold a thing before—not a dime's worth. If you had told one of them that he could sell he would have laughed at you.

They were frankly skeptical. Yet every one of these men, through reading this book, discovered the fallacy of this vicious old idea that Salesmen are "born." They learned that Master Salesmen are made! And in this book they found a comparatively easy way to go from low pay to better earnings.

Simple as A B C

Sounds remarkable, doesn't it? Yet there is nothing remarkable about it. There are certain ways to approach different types of prospects to get their undivided attention — certain ways to stimulate keen interest—certain ways to overcome objections, batter down prejudices, outwit competition and make the prospect act. If you will learn these principles, there is awaiting you a brilliant success and more money than you ever thought of earning. This book "Modern Salesmanship," tells exactly how the National Salesmen's Training Association will make you a Master Salesman.

As soon as you are qualified and ready, the Employment Service of the National Salesmen's Training Association will help you to select and secure a selling position as city or traveling salesman.

Now Free to Every Man Who Will Act at Once

We are not making any extravagant claims about what we will do for you. We don't have to. The records of the real successes for which we are responsible are so overwhelmingly a testimonial of the fact that any man of average intelligence can become a Master Salesman that we are willing to leave the decision entirely up to you. All of this proof and many important features about Salesmanship are contained in "Modern Salesmanship." It is yours—FREE. Send the coupon for it today. It will show you how you can quickly become a Master Salesman—a big money maker. It will tell you about the National Salesmen's Training Association system of Salesmanship Training that has meant prosperity to so many thousands of men—about the National Demonstration Method that gives you actual experience while studying—and all about the fine opportunities that await you in the selling field. Failure to act may mean that you lose the one big chance of your life to leave forever behind you the low pay of a routine job.

National Salesmen's Training Association
Dept. 15-M
53 W. Jackson Boulevard
Chicago, Ill.

WORLD'S OLDEST AND LARGEST SALESMANSHIP TRAINING INSTITUTION
NATIONAL SALESMEN'S TRAINING ASSOCIATION

National Salesmen's Training Association
Dept. 15-M,
53 W. Jackson Boulevard, Chicago, Ill.

I simply want to see the facts. Send me FREE your Book, "Modern Salesmanship" and Proof that I can become a Master Salesman.

Name.....

Address.....

City..... State.....

Age..... Occupation.....

MEN WANTED!

I am teaching trades to men who want to get out of white collars and into overalls. Who want to quit being wage slaves, whose job a strike or bad business or employer's whim can terminate without warning. Who want a chance to be independent, make real money and own their own business.

I refer you to sixty thousand men who found the way to success by sending for my catalog.

The white-collar worker contemplating a shift into a manual trade will find, with a little investigation, that the trades themselves are shifting. Yesterday he would have tackled something like carpentering, bricklaying, plastering, painting or typesetting. Today he finds a demand for men who understand automobiles, internal-combustion engines, electricity, oxy-acetylene cutting and welding, and other crafts of comparatively recent development. Ten or fifteen years ago many of them did not exist. They have come into existence with the growth of internal-combustion power and the changed character of building.

—*Saturday Evening Post.*

"The White Collar Shifts Into Overalls"

Earn $50 a Week and Up!

If you are looking for work at $50 a week and up, if you would like to get into something sure and solid that will give you success and independence, and can put in a few weeks this winter in TRAINING, write me today.

With over TWELVE MILLION automobiles running the demand for mechanics, demonstrators, chauffeurs, truck drivers, garage men, etc., is greater than ever before. Countless opportunities in cities and towns and even remote places. I estimate there are 20,000 Sweeney trained men owning their own garage or business.

FREE Catalog and Special Offer

Get my FREE 64-page catalog. It shows hundreds of actual photographs of men at work in my magnificent new school. Tells all about wages, profits, opportunities in auto and tractor business. Explains step by step how to learn. Interesting letters from graduates telling how they made good. Shows how men come from all over the world to this big school. Makes you want to join the crowd. Tells everything you want to know. I will gladly send you a copy, beautifully illustrated. I'll tell you how to get into business for yourself. No colored students accepted.

Send This Now

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is the ONLY way to learn if you want to save time and money and be properly trained. You get this at the famous trade school, the MILLION DOLLAR SWEENEY SCHOOL and you get it nowhere else. I have helped 60,000 men to success. The way to learn is easy. You don't need any experience, age makes no difference. I teach with tools, not books. You learn by actually doing the work. I am making a *Special Thirty Day Offer*. That is why you should not delay. The first step is to send for my big Free Catalog.

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Dept. 10-J, Sweeney Building, Kansas City, Mo.

Send me free, without any obligation on my part, your 64-page catalog and Special Offer.

NAME.....

GIVE AGE .....

P. O. .....

STATE .....

ELECTRICITY

Let Me Show You How to Make It Bring You $9000 a Year

You men who are slaving away in small-pay jobs, hoping and striving for better things, I wish you could be with me here for just a few moments. I would show you how thousands of men just like yourself have quickly stepped into high-salaried positions and brilliant success in this fascinating field of electricity. In each and every case their first step toward this cherished goal was to write to me for the same *free proof* I want to send to you. They followed my advice and today are leading happy, prosperous lives—many drive their own cars, own their own homes and have plenty of money to spend for the other good things of life. They are Electrical Experts—"Cooke-Trained"—earning $3500 to $10,000 a year!

Be an Electrical Expert Learn at Home

Get into this great field of Electricity! Know the magic force, the ways and means it is harnessed for use in industry, and a thousand jobs will be opened to you at salaries far beyond your fondest dreams. Read Pence's story at the right! Let it be your guide post to success! Hundreds of other Cooke-Trained men have done as well, and many better! And how? Simply by taking this specialized training that quickly fits any man, no matter what his age or previous education, to take his place with the big-pay men of the country. You needn't give up your present job or go away to school; by this amazing method you may *learn right at home in your spare time.*

$3500 to $10,000 a Year

Twenty years of actual work all over the world in the electrical field gave me a grasp of just what a man must learn to fill an important position. My experience taught me that a man must know first the principles involved and then the *best methods* to apply and regulate those principles. Why make a man wade through a lot of useless study, wasting months of precious time. And so, at enormous expense and years of effort I evolved a system of training that is stripped of every useless step. I will make the student a practical worker! I will place in his head and hands the means to make big money as a skilled Electrical Expert! I will fit him in a *short time* to earn a princely salary, $3500 to $10,000 a year, for his skill!

Thousands of Happy Men Say "There Is No Other Training Like This"

"You have given me a most wonderful training, a training no other school can, I feel sure, approach, much less duplicate," says F. E. Radcliffe, one of my boys who is making good in Ohio. I wish you could see the thousands of letters I get like this! John Burke of Baltimore *made* $750 *in* spare time before he finished his training! Think what this means to you! No frittering away time serving a costly apprenticeship! Every step in this fascinating training adds earning power. You quickly become a practical man, ready to fill a big-pay job.

Many of my boys set up in the Electrical Contracting business, wiring houses, repairing motors, generators, electrical appliances, installing farm lighting systems, etc. Others set up shops and spaces in garages for repairing electrical systems on automobiles, trucks, motorcycles, etc. They are fitted at once to start in business for themselves, with practically no investment. And with the big plants, even the ordinary electrician makes big money. But the Trained Expert is the man who is *Boss*—he is the big-pay man. With the training behind you, you can claim such an enviable place for yourself.

You Cannot Lose—I Guarantee Your Complete Satisfaction

You don't have to take my word for one thing. So sure am I that after taking this training you can step right into a high-salaried position, and you will thrill with the newly found power that is yours, that I guarantee under bond to return every cent of tuition you pay me, if you are not absolutely satisfied that it is the best investment you ever made. Electricity needs you—it offers you boundless opportunity for a brilliant career. I have tried to remove every stumbling block toward accomplishing your ambition. I will help you win, if you will let me!

FREE—If You Act Now—FREE Big Electrical Outfit

I know that it is only by practice with actual instruments and materials that a man can become a *practical electrical expert.* For that reason I give you without charge or stipulation a Complete Outfit of Electrical Tools, Materials, and Measuring Instruments. I also furnish you with supplies, examination paper and many other things that other schools don't furnish. You actually start early in the course to work at your profession, rapidly becoming proficient, ready to do any electrical job.

EXTRA—A Course in RADIO Given FREE for a Short Time

The up-to-date Electrical Expert must know radio or wireless work, how to make and repair the various equipment. This is a mighty profitable field today, and many men are making big money in it. Because I want to make this my banner year, I am now giving this $45.00 Course in Radio *absolutely Free* to new students. Don't miss this remarkable offer which might be withdrawn at any time.

Make up your mind now to get into this great profession quick. Every day lost keeps you away that much longer from prosperity and happiness! Mail the coupon today for my big free book, "How to Become an Electrical Expert," and other free proof that I can put you into the class with Pence and thousands of other Cooke-Trained men who are making princely incomes.

L. L. COOKE,
Chief Engineer,
CHICAGO ENGINEERING WORKS,
Dept. 36, 2150 Lawrence Ave.,
CHICAGO, ILL.

$9000 A YEAR

The picture above shows Mr. W. E. Pence of Albany, Oregon, in his working togs. Pence is a "Cooke-Trained" man, and his letter below shows what he thinks of my course.

Dear Mr. Cooke:
Thought you would be interested in a hand-bill I have just gotten out regarding my new shop. Business is going strong, paying me now something over $750 a month above my expenses.
And I must thank you again for my success, because it was your wonderful course and method of instruction that put me where I am.

Your true friend,
W. E. PENCE.

MAIL COUPON TO-DAY

L. L. COOKE, Chief Engineer
Chicago Engineering Works, Dept. 36
2150 Lawrence Ave., Chicago, Ill.

Send me at once "How to Become an Electrical Expert" with other proof that I can become a big-pay Electrical Expert through your Training. Register me for your Special Free Offers. You send this FREE without any obligation on my part.

Name.....
Address.....
City..... State.....
Occupation..... Age.....

The "Cooke" Trained Man is the "Big Pay" Man

Money Making Opportunities for "Popular Science" Readers

AUTOMOBILES AND ACCESSORIES

PATENTS—Write for our Guide Books and "Record of Invention Blank" before disclosing inventions. Send model or sketch of your invention for our free Examination and Instructions. Terms reasonable. See advertisement on page 121. Victor J. Evans & Co., 189 Ninth, Washington, D. C.

AUTOMOBILE Parts—Used parts for most any car at half factory list prices. Allen, Briscoe, Buick, Cadillac, Chalmers, Chevrolet, Dodge, Dort, Grant, Hudson, Hupmobile, Oakland, Overland, Oldsmobile, Reo,Studebaker and many others. Send list of parts wanted. Century Auto Parts Co., 4105 Olive Street, St. Louis, Missouri.

$1.25 BUYS a positive Headlight Tell-tale. Handy Specialty Co., Somerville, Mass.

SPORT Speedster and racing bodies for Fords; build to order. Build your own Bucket Seat speedster. Send $1.00 for blue prints, instructions, and life size paper patterns, complete; Keller Auto Body Co., Inc., Dept. 24, 317 W. Winkler Ave., Louisville, Ky.

MONEY!—Silvering autolights, radiators, mirrors. Refinishing tableware, stoves, brass beds, etc. Outfits, Methods free. Write—Sprinkle-Plater, Dept. 96, Marion, Indiana.

BUY a Gas Gun for $2.50 and avoid stopping on the road because out of gas. Handy Specialty Co., Somerville, Mass.

PROTECT your springs with positive (inexpensive) spring leaf Lubricators. Automatic Spring Oiler Co., Drawer 18, Corona, N. Y.

FORD ACCESSORIES

SPEEDSTER fans—see "Red-i-Kut" ad. page 130.

MOTORCYCLES, BICYCLES, SUPPLIES

OVERSTOCKED—200 Used Motorcycles. Must be sold at once. We have Harley-Davidsons, Indians, Hendersons, Excelsiors, Clevelands. Prices $25.00 Up. Write for our Bargain List. Myerow Brothers, Dept. C, 15 Berkeley St., Boston, Mass.

DON'T buy a bicycle motor attachment until you get our catalogue and prices. Shaw Mfg. Co., Dept. 4, Galesburg, Kansas.

USED parts for all motorcycles cheap. Schuck Cycle Co., 1922 Westlake, Seattle, Wash.

AVIATION

THE American School of Aviation announces a new correspondence course in mechanics of aviation. A thorough training in practical aeronautics. American School of Aviation, Dept. 674-B, 3601 Michigan Ave., Chicago, Illinois.

BOYS get a three foot model aeroplane free. Nothing to sell. Write to Aero Shop, 3050 Hurlbut Ave., Detroit, Michigan.

MOTORS—BOATS—LAUNCHES

BOATS that always Go are propelled by Ford engines. Ford boat dope sent free. Harry Rider, 206C Commercial Bldg., Norwalk, Conn.

MOTORS, ENGINES AND MACHINERY

MOTORS—Manufacturer's Surplus Sale. ¼HP, $8.50; ½HP, $32.50; 1 HP, $54.50. 8 Volt Charging Generators, $8.50. Complete Lighting Plants—Generators—Light Machinery. Write for Catalog. Motor Specialties Co., Crafton, Penna.

CONCRETE Building Block Machines and Molds. Catalogue free. Concrete Manufacturing Co., 307 So. Third St., St. Louis, Mo.

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HULIT & Co., 625 Jackson, Chicago, Ills. Experimental Machinists. Model Makers. Dies. Patterns. Complete general Machine shop. Ex-Lamson.

WE make working models for inventors and experimental work, and carry a complete stock of brass gears and model supplies. Send for catalogue. The Pierce Model Works, Tinley Park, Illinois.

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DIES, Tools and General Manufacturing. Models and manufacturing of new inventions our specialty. Logan Machine Co., 126 S. Clinton St., Chicago, Ill.

DEVELOPING ideas and manufacturing our specialty. Absolute satisfaction. 33 years' experience; write us. The K. & B. Die & Specialty Co., 2018 Elm St., Cincinnati, Ohio. Dept. C.

FOR THE HOME

GRANDFATHER clock works $5.00. Build your own case, instructions free; make good profits selling your friends. Clock works with chimes for old or new cases. Write for full particulars. Clock Co., Nicetown, Penn.

GASOLINE lamps, lanterns and heaters. Catalog free. Little Wonder Mfg. Co., Terre Haute, Indiana.

BEAUTIFUL child's china cabinet, patterns, instructions 25c. Circular Free. Brogrens Kiddy Kabinets, 2651 8th Avenue, New York.

PURCHASE a beautiful Electric Fountain for your home at Jobber's price. Walter L. Haanel & Co., 4521 Ravenswood Ave., Chicago.

SAVE 1-5 to 1-2 the money you spent for coal last year, and get more heat by attaching the CROWN Fuel Saver to the feed door of your furnace. This inexpensive device is an amazing heat-producer and coal-saver. Works automatically—never gets out of order. Guaranteed to save 20% of coal or money refunded. Write CROWN CO., 14 N. 10th St., Richmond, Ind.

Another $25.00 IN PRIZES

To win one of these cash prizes is easy, and every reader is invited to enter this fascinating competition. Just write a letter of not over seventy words answering this question:—

What Advertisement of "Money Making Opportunities" in this issue interests you most and why?

Here are the prizes we will pay for the ten best letters answering the above question:—

First Prize	**$10.00**
Second Prize	**5.00**
Third Prize	**3.00**
And 7 Prizes of $1.00 each	**7.00**

First read every one of the "Money Makint Opportunity" advertisements on pages six to twenty. Check the ones that interest you. Then read over the ones you have checked and decide on the one that interests you most.

Then write a short letter, not more than seventy words, telling us why the advertisement you pick interests you most. Remembet that ten prizes will be awarded. You have a good chance of winning one of them. Be sure to mail us your answer before Sept. 1st. The prizes will be awarded, in the order of their merit, for the letters that are most interesting and best expressed.

The names of all the prize winners and the letters that win the first two prizes will be printed in this column in the November issue. Address your prize letter to

Contest Editor
POPULAR SCIENCE MONTHLY
250 Fourth Ave., New York City

Last Month's Prize Winners

The First Prize of $10.00 goes to George Dawson, Montreal, Canada, for his letter on the advertisement of "The Union Loom Works." Here is Mr. Dawson's letter:

> Dear Sir:—
> "Money Making Opportunities" as per ads in Popular Science, touches the spot every time. I soon found my "money making opportunity" through the offer of "The Union Loom Works" ad, a sure and profitable business getter at all seasons. I have at present more orders than I can fill at practically my own price, and there appears to be no limit.
> GEORGE DAWSON

Mr. S. F. Howard, Jr., Iuka, Miss., wins the Second Prize for the following letter regarding the advertisement of the R. J. Carnes Company. Here is Mr. Howard's letter:

> Dear Sir:—
> While looking over Popular Science Monthly for a "money making opportunity" to take up in my spare time, the advertisement of R. J. Carnes, Tallapoosa, Georgia, struck me as being exactly what I wanted. It is a real money-making offer, such as I can always find in Popular Science Monthly: not a fake "get rich quick" scheme, but a fair, straightforward, open opportunity for any person who is looking for such.
> S. F. HOWARD, JR.

The Third Prize goes to C. M. Reynolds, Spruce Creek, Pa.

The winners of the other seven prizes are:—

S. E. Miller, Corry, Pa., Mrs. Bertha Brooks, Long Prarie, Minn., James E. Noble, Toronto, Canada, Estes Hawkes, Drummond, Idaho, Julian B. Tuthill, Sayville, N. Y., George D. Reynolds, Altoona, Pa., and James Monticue, Canton, Ohio.

Rate 25 Cents a Word. Advertisements intended for the November issue should be received by September 5th.

RADIO AND SUPPLIES

RADIO Tubes repaired and exchanged; write for free circular, "How to do Away with Storage Batteries on All Tubes." C. F. E. Radio Tube Works, Essex Court, Newark, N. J.

RADIO Generators: 500v 100 watt, $28.50. Battery Charging Generators, $8.50. High Speed Motors. Motor Generator Sets all sizes. Motor Specialties Co., Crafton, Penna.

2,650 MILES Distance with one tube. Any Novice understands our Simplified Instructions, including Panel Layout and Photo 25c. Vesco Radio Co., Box PS 117, Oakland, Calif.

RADIO tubes, D11, D12, UV199, UV200, UV201A, $4.25. Dutch radio tubes, D12, D200, D201A, $2.50. Crystal set, 50c. Add postage. Radio Sales Co., 1168 North Kingshighway, St. Louis, Mo.

WHY Not Reach Out with your crystal set? There's music on your aerial every night from stations far away! I have shown thousands of people how to hear long distance programs without tubes. Write me today. Leon Lambert, 670 South Volutsia, Wichita, Kansas.

EDUCATIONAL AND INSTRUCTION

DOUBLE entry bookkeeping mastered in 60 hours; guaranteed; diploma. International Bookkeeping Institute, Springfield, Missouri, Desk 10.

LINCOLN-JEFFERSON University. Home Study in Academy College, Theological, Law, Music, Pharmacy, Business and Graduate schools, leading to degrees. Box G, Capitol Building, Chicago.

USED correspondence courses bought and sold. Bargain catalogue 1000 courses free. Students' Exchange, Dept. 3, 47 West 42d Street, New York.

BOOKKEEPING in a week, $1 postpaid. Dukes, 1859 Walton, Ave., New York.

MATHEMATICS and Drafting taught by mail. Courses in Arithmetic, Algebra, Geometry, Mensuration, Trigonometry, Logarithms, Mechanics, Mechanical Drafting, and Tool Designing. Harding School, Box H, Highland Park, Mich.

ALL men, women, boys, girls, 17 to 65, willing to accept Government Positions, $117-$250, traveling or stationary, write Mr. Ozment, 295, St. Louis, Mo., immediately.

DETECTIVES needed everywhere; cities, towns. Particulars free. Write National Detective System, 188 East 79th, New York.

FIREMEN, Brakemen, Baggagemen, Sleeping car, train porters (colored). $140-$200. Experience unnecessary. 838 Railway Bureau, East St. Louis, Ill.

WRITE photoplays; $50 each. Experience unnecessary; details free to beginners. Producers' League, 312, St. Louis.

RAILWAY Mail, Postoffice Clerks, Carriers, Customs, and many other positions open,—$1400-$2300 yearly. Write today for 36 page booklet showing how to obtain one of these desirable life positions. Chicago Civil Service College, T-70 Kesner Building, Chicago.

BE a detective. Excellent opportunity to earn big money, travel, thousands of dollars offered in rewards. Established 1909. Particulars free. Write to C. T. Ludwig, 424 Westover Bldg., Kansas City, Mo.

MEN—Experience unnecessary; travel; make secret investigations; reports; salaries; expenses. Write American Foreign Detective Agency, 321, St. Louis, Mo.

RAILWAY Postal Clerks—Start $133 month. Railroad pass; expenses paid; questions free. Columbus Institute, N-2, Columbus, Ohio.

DETECTIVES Earn Big Money. Excellent opportunity. Travel. Fascinating work. Experience unnecessary. Write, George Wagner, former Government Detective, 1968P Broadway, N. Y.

TRADE AND TECHNICAL SCHOOLS

EARN $10 to $20 per day. Learn sign painting, Auto painting, decorating, paperhanging. Be an expert in a few weeks—Low cost—Actual work—No books—Catalog Free. Chicago Painting School, 157 West Austin Avenue, Chicago.

CHICAGO Technical College offers short, intensely practical courses in Drafting and Engineering—civil, mechanical, electrical, structural—Architecture, Building Construction, Plan Reading, etc. Courses fitted to your needs. No time wasted. Instructors are experts. Graduates in demand at big salaries. Opportunities for part-time work while studying. Day and evening classes. 21st year. Enter any time. No special preliminary training required. Low tuition—easy terms. Write for 52-page illustrated Blue Book, describing opportunities open to our graduates. Chicago Technical College, 23 Chicago Tech. Building, Chicago.

BE a Bricklayer. Attend a school operated by Building Contractors. Three Months Day Course $75.00. Associated Building Employers, 128 A. B. E. Building, Grand Rapids, Mich.

WANTED

WANTED: Light Machinery, Lathes, Drill Presses, Model High Speed Gasoline and Steam Motors. Best Cash Prices Paid. Motor Specialties Co., Crafton, Penna.

DETECTIVES needed everywhere. Experience unnecessary. Particulars free. Write, George Wagner, former Government Detective, 1968P Broadway, N. Y.

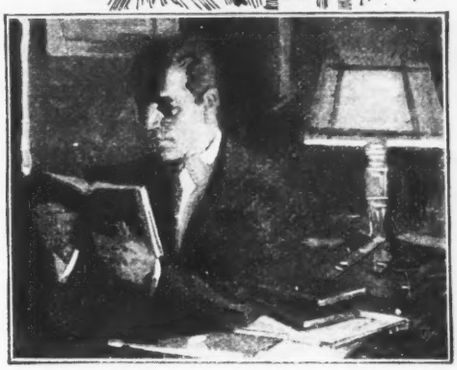
WANTED—Representatives in every factory in the United States. Popular Science Monthly, 225 West 39th Street, New York.

AMERICAN MADE TOYS AND NOVELTIES

OPPORTUNITY to start Manufacturing Metal Toys and Novelties. No experience necessary. Enormous demand exceeds supply. We furnish, at cost, castingforms for production and buy entire output, also place yearly contract orders. Casting forms made to order. Catalog, advice and information free. Metal Cast Products Co., 1696 Boston Road, New York.

More Money Making Opportunities on pages 8 to 20

Making Successful Men
by Home-Study Training



How can I make more money? How can I advance more rapidly in business? Literally millions of untrained men—yourself, perhaps, among them—are continually disturbed by those two questions.

"Be industrious; keep everlastingly at it"—that's the way the writers of *copy-book maxims* would tell you to go about it. But honestly—are you fooled by that sort of talk? Why, you yourself know dozens of fellows who work just as hard as beavers, yet draw barely enough to keep them alive!

Argue it any way you like, it takes something beside mere *work* to push men ahead—it takes *specialized* work.

And to suggest, for a second, that an untrained man—no matter how hard he works—is going to be promoted to a highly specialized position—such as that of Auditor, or Traffic Manager, or Sales Executive, or Expert Correspondent, or Production Manager, or Legal Counsellor—without first *equipping* himself for that position, is as absurd as to intimate that the boatman in the park who has been on the job for twenty years is likely to be chosen captain of a trans-Atlantic liner!

* * *

Recognizing these facts—and surely no one can dispute them—what is the wise thing to do to change one's situation for the better?

Many a happy-go-lucky chap will tell you that all you need do is to keep your eyes open and promotion will take care of itself.

It will. *But, oh, how slowly!*

While one man is advancing by this tedious route from $25-a-week to $30-a-week to $35-a-week, another chap, not a bit smarter than he, is climbing from $15-a-week to $30-a-week to $50-a-week to $100-a-week.

If you doubt it, look about you! Talk with the men still in their twenties and early thirties who are swinging $5,000 jobs!

No—there's more to advancement than merely "catching onto things." TIME is the all-important factor—and that is the big reason why thousands of earnest men have refused to wait, but have turned instead to LaSalle Extension University and have shortened by many years their journey to success.

That they—in so doing—have acted to their own advantage is borne out by the fact that during only three months' time as many as 1193 members reported definite advancement which they were frank to attribute to home-study training under the LaSalle Problem Method. The total salary-increases so reported amounted to $1,248,526, *an average increase per man of eighty-nine per cent.*

* * *

Your future is, of course, your own problem—and no one can solve it but yourself. If you are content to drift, you will find plenty of company though little profit.

If, on the other hand, you are really in earnest when you say that you want to get ahead in business, you will find both companionship and gain in home-study training under the LaSalle Problem Method.

Below this text there's a coupon—very similar to the one which has set many, many thousands on the path to success.

A good way to gauge your strength of purpose is—by what you do with that coupon—NOW.

LA SALLE EXTENSION UNIVERSITY

The Largest Business Training Institution in the World

LASALLE EXTENSION UNIVERSITY Dept. 983-R Chicago, Illinois

Please send me catalog and full information regarding the course and service I have marked with an X below. Also a copy of your book, "Ten Years' Promotion in One," all without obligation to me.

☐ **Business Management: Training for** Official, Managerial, Sales and Departmental Executive positions.

☐ **Modern Salesmanship: Training for position** as Sales Executive, Salesman, Sales Coach or Trainer, Sales Promotion Manager, Manufacturer's Agent, Solicitor, and all positions in retail, wholesale, or specialty selling.

☐ **Higher Accountancy: Training for position** as Auditor, Comptroller, Certified Public Accountant, Cost Accountant, etc.

☐ **Law: Training for Bar; LL. B. Degree.**

☐ **Commercial Law: Reading, Reference** and Consultation Service for Business Men.

☐ **Traffic Management—Foreign and Domestic: Training for position as Rail**road or Industrial Traffic Manager, Rate Expert, Freight Solicitor, etc.

☐ **Railway Station Management: Train**ing for position of Station Accountant, Cashier and Agent, Division Agent, etc.

☐ **Banking and Finance: Training for** executive positions in Banks and Financial Institutions.

☐ **Modern Foremanship and Production Methods: Training for positions in Shop** Management, such as that of Superintendent, General Foreman, Foreman, Sub-Foreman, etc.

☐ **Industrial Management Efficiency: Training for positions in Works Man**agement, Production Control, Industrial Engineering, etc.

☐ **Personnel and Employment Manage**ment: Training in the position of Personnel Manager, Industrial Relations Manager, Employment Manager, and positions relating to Employee Service.

☐ **Modern Business Correspondence and Practice: Training for position as** Sales or Collection Correspondent, Sales Promotion Manager, Mail Sales Manager, Secretary, etc.

☐ **Expert Bookkeeping: Training for** position as Head Bookkeeper.

☐ **Business English: Training** for Business Correspondents and Copy Writers.

☐ **Commercial Spanish: Training for** position as Foreign Correspondent with Spanish-speaking countries.

☐ **Effective Speaking: Training in the** art of forceful, effective speech, for Ministers, Salesmen, Fraternal Leaders, Politicians, Clubmen, etc.

☐ **C. P. A. Coaching for Advanced Ac**countants.

Name..... Present Position..... Address.....

$90 Drafting Course FREE

There is such an urgent demand for practical, trained Draftsmen that I am making this special offer to deserving, ambitious men. I will teach you to become a Draftsman and Designer until you are **drawing a salary of $250.00 a month.** You need not pay me for my personal instruction or for the complete set of instruments. **But you must take advantage of this special offer at once.**

$300 a Month Salary— $450 on the Side At Home

That's the kind of money my drafting students make. Read what this one says:

Chief Draftsman Dobe

"As a beginner I am doing fine. Am earning a salary of $300 per month, besides I made over $450 at home the last two months, drawing plans for private parties. The practical drafting training you gave me by mail put me where I am in less than six month's study. Thank you for all your personal interest and help you gave me so far." (Signed) J. B.

(Name and address upon request)

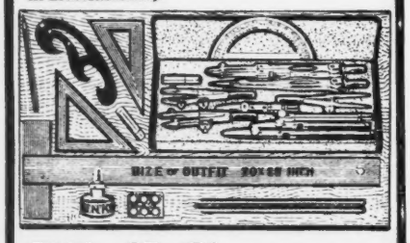
Write and I'll tell you how I make you a first-class, big-money-earning draftsman in a very few months! I do this by a method no other man or institution can imitate. I give you personal training at home by mail until you are actually placed in a position paying up to $250 and $300 a month. Six thousand draftsmen wanted every month.

I Guarantee

To train you until you are placed in a position paying up to $250 and $300 a month

This Outfit FREE

I give you a whole set of drafting tools the minute you become my student. You get every tool you need. A magnificent set of instruments which will build your success in draftsmanship



Mail Coupon

at once for my great book — "Successful Draftsmanship." Find out about the simply marvelous opportunities ahead now. What great salaries and possibilities there are! Send the coupon for free book TODAY!

Free Course Offer Coupon

CHIEF DRAFTSMAN DOBE
1951 Lawrence Ave., Div. 13-66, Chicago

Without any obligation to me please mail your book, "Successful Draftsmanship" and full particulars of your liberal "Personal Instruction" offer to a few students. It is understood I am obligated in no way whatever.

Name..... *Age*.....

Address.....

Money Making Opportunities

ADVERTISING

ADVERTISE in 24 metropolitan dailies, 24 words, $15.00. Helpful Guide listing 1000 publications, 4c stamps. Wade Company, Baltimore Bldg., Chicago.

28 WORDS in 80 Country Town Newspapers, $3.40. Shaw, 221 A. Northeast, Washington, D. C.

ADVERTISING rates for magazines and weeklies free. Charles A. Lutz, Apartment 241, York, Pennsylvania.

24 WORDS combine list of 70 Sunday and weekly newspapers, $6.00. AdMeyer, 4112 P, Hartford,, St. Louis.

ONE Inch in 136 N. Y. Country Weeklies $15. Only one cut needed. The Messenger, Smithtown Branch, Long Island.

ADVERTISING in all magazines and newspapers at publishers' lowest rates. Sales letters, booklets, folders, planned, written, illustrated. Taylor's Advertising Service, Dept. A, Freeport, Illinois.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager, Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

PRINTING, ENGRAVING, MULTIGRAPHING

ENVELOPES or Shipping Tags at sensible prices. R. D. Elliott, 305 South Third, St. Louis.

COMMERCIAL Printing. Write requirements. Franklin Press, B-34, Milford, New Hampshire.

500 TWO Color Letterheads, $2.75. Samples free. Superior, 1825 Roosevelt, Indianapolis.

BETTER Printing for Less Money. Write us about your printing needs, and you will save money. Ernest Fantus Company, 525 South Dearborn Street, Chicago.

EMBOSSED business, personal stationery. Samples, stamp. Daniels P. Company, Pittston, Pennsylvania.

YOUR name and address printed on 100 fine cards for 50c, prepaid. Greenfield Printing Co., 191 Osborn St., Brooklyn, N. Y.

100 EACH, Letterheads and Envelopes, $1.00. Culpepper Press, Box S5, Faith, Ark.

TRADE-MARKS, letterhead designs, illustrations for advertising. Letters, folders, booklets written. Quick service, fair prices. Taylor's Advertising Service, Dept. B, Freeport, Illinois.

SIMPLE Photo-Engraving Process. Line and Half-tone Cuts. Particulars 2 cents. Horton and Fisher, Princeton, Ill.

GUMMED LABELS

NAME and address, 500, 30c. Others rolls or loose. Stationery, 200 sheets and 100 envelopes printed $1.00. Eastern Label Co., B, Clintonville, Conn.

DUPLICATING DEVICES

STENCIL Duplicating Outfit—$2.00, $3.00, $4.00. Prints Typewriting, Handwriting, etc. On Approval. Primos Specialty Co., 3-X, Primos, Pa.

"MODERN" Duplicators, save Time, Labor, and Money. Gets business. Reproduces Typewritten or Penned Letters, Drawings, Lessons, Music, Menus, Bids, Notices, Specifications, Maps or anything in one or more colors. Prints two per minute. Special sale on. 30 days' free trial, $2.25 up. Booklet free. J. V. Durkin-Reeves Co., Pittsburgh, Pennsylvania.

OFFICE DEVICES

ADDRESSING machines, multigraphs, duplicators, folders, check writers, sealers, dictating machines, at about half new cost. Pruitt, 170-Z North Wells, Chicago.

ADDING MACHINES

FREE trial, marvelous free adding machine. Adds, subtracts, multiplies, divides, automatically. Work equals $350.00 machine. Price only $15.00. Speedy, durable, handsome. Five-year guarantee. Used by largest corporations. Write today for catalog and free trial offer. Lightning Calculator Co., Dept. O, Grand Rapids, Michigan.

BRANCH OFFICE SERVICE

PITTSBURGH Office and Representation Free. Pittsburgh Office Service, 973 Union Trust Bldg.

LETTER SPECIALISTS

20 SUCCESSFUL Collection Letters $1. Win, 405 Gotham Bank Bldg., New York, N. Y.

LET me write your sales letters, booklets, folders. Wide experience, fair prices, quick service. L. Taylor, Box 44P, Freeport, Illinois.

MAILING LISTS

12,000 NAMES Indiana High School Graduates, $3.00 —Harvey Morley, Angola, Ind.

LABORATORY AND CHEMICAL SERVICE

EXPERIMENTERS. Complete supplies for the chemical laboratory. Catalogue 5c. National Scientific Supply Co., 241 Pennsylvania Avenue, Washington, D. C.

YOUR chemical problem solved and working process furnished for five dollars. Write me. W. Stedman Richards, Consulting Chemist, Box 2402, Boston, Mass.

FORMULAS

FORMULAS for useful and salable articles. Four hundred in book form. Fifty cents, postpaid. Pentland Service, 1 Thames Ave., Norwalk, Conn.

INFORMATION

COMPLETE, accurate, information on any subject, $1. National Information Bureau, 1429P Milton St., Grand Rapids, Michigan.

LEGAL questions answered, guaranteed correct, $1.00. Edgar Keller, Augusta, Montana.

INCORPORATIONS

DELAWARE Incorporator. Charters; Fees Small; forms. Chas. G. Guyer, 901 Orange St., Wilmington, Delaware.

INCORPORATE Delaware. F. Lewis Mettler, 832 Market St., Wilmington, Del. (Established 1909.)

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. Manager, Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

More Money Making Opportunities on pages 6 to 20

HIGH SCHOOL COURSE IN TWO YEARS

YOU ARE BADLY HANDICAPPED if you lack High School training. You cannot attain business or social prominence. You are barred from a successful business career, from the leading professions, from well-paid civil service jobs, from teaching and college entrance. In fact, employers of practically all worth-while positions demand High School training. You can't hope to succeed in the face of this handicap. But you can remove it. Let the American School help you.

FIT YOURSELF FOR A BIG FUTURE This course, which has been prepared by some of America's leading professors, will broaden your mind, and make you keen, alert and capable. It is complete, simplified and up-to-date. It covers all subjects given in a resident school and *meets all requirements* of a High School training. From the first lesson to the last you are carefully examined and coached.

USE SPARE TIME ONLY

Most people *idle* away *fifty* hours a week. Probably you do. Use only one-fifth of your wasted hours for study and you can remove your present handicap within *two years.* You will enjoy the lessons and the knowledge you will gain will well repay the time spent in study.

Check and mail the coupon NOW for full particulars and Free Bulletin.

American School
Dept. H675,
Drexel Ave. and 58th St., Chicago

American School
Dept. H675, Drexel Ave. & 58th St., Chicago
Send me full information on the subject checked and how you will help me win success.

.....Architect	.....Lawyer
.....Building Contractor	.....Machine Shop Practice
.....Automobile Engineer	.....Photoplay Writer
.....Automobile Repairman	.....Mechanical Engineer
.....Civil Engineer	.....Shop Superintendent
.....Structural Engineer	.....Employment Manager
.....Business Manager	.....Steam Engineer
.....Cert. Public Accountant	.....Foremanship
.....Accountant and Auditor	.....Sanitary Engineer
.....Bookkeeper	.....Surveyor (& Mapping)
.....Draftsman and Designer	.....Telephone Engineer
.....Electrical Engineer	.....Telegraph Engineer
.....Electric Light & Power	.....High School Graduate
.....General Education	.....Fire Insurance Expert
.....Vocational Guidance	.....Wireless Radio
.....Business Law	.....Undecided

Name.....

Address.....

CARPENTRY SELF TAUGHT!!

Be A SKILLED Workman and Hold Your Job in Dull Seasons

Do you know that even when work seems hardest to get, building contractors are complaining that they can't get enough skilled carpenters? Almost any man that says he is a carpenter can get a job in the building season, but it depends on what a man *KNOWS* whether he gets laid off at the first dull week or not. Spare time reading and study of AUDEL'S GUIDES will help make you the kind of skilled workman that is never out of a job.

New Ideas-Modern Methods-Short Cuts

This course "Audel's Guides for Carpenters and Builders" consists of 4 handy volumes of over 1500 pages with thoroughly illustrated charts, diagrams, graphs, pictures with calculations for every job from making the excavation to constructing the entire building. You will find these new Guides most complete and comprehensive in addition to being both timely and practical. There are 3700 actual examples of efficient construction work with new methods, ideas, solutions, plans, systems, short cuts, time and labor saving suggestions, new ways that cover the entire theory and practice of the subject illustrated by sketches and forms all specific and practical. Audel's Guides give you the short cut, professional information you want. No need to guess or take chances. Every day you have before you in this set the exact, practical, useful information that will help you with every job that comes up in your daily work.

Thousands Say Guides Are Carpenter's Best Friend

"Reasonable Price"

I find the Guides very satisfactory. The knowledge in them is much greater than I anticipated. A very convenient size and price is so reasonable that every carpenter should possess a set. —Ralph M. Collemer, Lowell, Mass.

"Valuable for Beginners or Old Timers"

I have looked over my Audel Guides and find a wealth of information. Their size makes them very handy to carry right onto the job. I have put my books in my tool kit and have them for ready reference. The arrangement of subjects and the simple way it is explained make the books very valuable for the beginner. The rules and formulas are mighty handy for the old timers.—Ross Smith, Sommers Point, N. J.

"Good For Professional Carpenters"

It is the most handy reference work that I ever came in contact with. It is the very thing that the building mechanic needs every day for reference. I wish to state further there is not a foreman or superintendent who can afford to be without this valuable work. I wish you unbounded success. —George H. Watson, 136 Munson St., Long Island City, N. Y.

"Guides Save Hard Knocks"

The Guides are truly wonderful and should be in the hands of all young carpenters as well as a lot of the older heads. If I had such information 20 years ago they would have saved me many a hard knock and also sleepless nights trying to figure out the next day's work. —G. M. McJohnston, R. R. 1, Hammond, Ind.

"Save Money"

The Guides have met with my complete satisfaction. Anyone expecting to build a home can well save $150 or more by using the information given in your books. W. E. Frantz, Box 77, Tuscarawas, Ohio.

"Good For Amateurs"

The books are surely worth more than the purchase price; especially as they serve as a guide to the non-professional like myself who is trying to build himself a home at the least expense. —Otto F. Schulze, P. O. Box 143, Westmont, Ill.

Condensed Contents of Audel's New Guides

Guide No. 1—Over 431 pages—1200 illustrations

- —How to know the different kinds of wood.
- —How to use the different kinds of wood.
- —Complete detailed information on nails and screws.
- —How circular and band saws are handled.
- —How to use the steel square.
- —How to sharpen tools.
- —How to file and set saws.
- —How to make wood joints.
- —Complete information regarding joints and joinery.
- —How to build furniture.
- —How to make a work bench.
- —How to make a mitre box.
- —How to make a mitre shooting board.
- —How to plumb and level work.
- —How to use the chalk line.
- —How to lay out work.
- —How to use rules and scales.
- —How to use all of the carpenter's tools, with over 900 illustrations showing specifically how.

Guide No. 2—Over 455 pages—400 illustrations

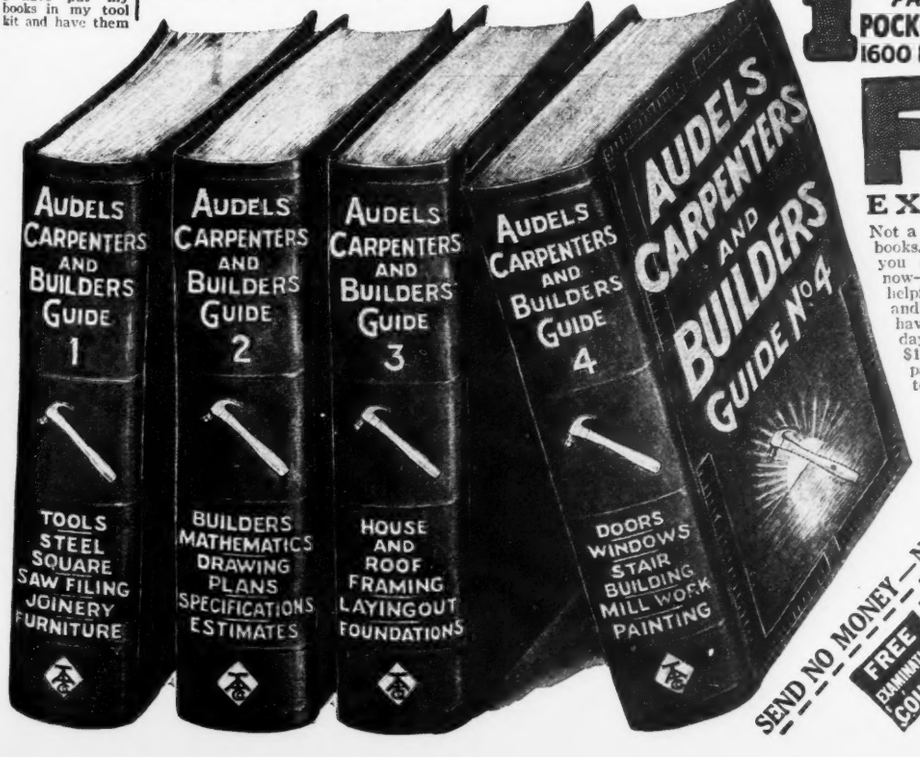
- —How to understand carpenter's arithmetic.
- —How to understand geometry.
- —How to understand trigonometry.
- —How to solve mensuration problems.
- —How to estimate the strength of timbers.
- —How to proportion beams.
- —How to use drawing instruments.
- —How to read plans.
- —How to survey.
- —How to draw up specifications.
- —How to estimate cost.
- —How to build houses, barns, garages, bungalows, etc.

Guide No. 3—Over 255 pages—400 illustrations

- —How to excavate foundations.
- —How to build foundations.
- —How to make water-proof.
- —How to erect post foundations.
- —How to build forms for concrete.
- —How to proportion foundation footings.
- —How to frame houses.
- —How to set girders and sills.
- —How to frame joists.
- —How to construct a well hole.
- —How to frame a studding.
- —How to frame corner posts.
- —How to lay out and cut braces.
- —How to attach lath to corner posts.
- —How to frame temporary and permanent braces.
- —How to frame girts and ribbands.
- —How to set window frames.
- —How to frame partitions.
- —How to distinguish various types of roofs.
- —How to use the settings 12, 13 and 17 on the steel square.
- —How to lay out mitre cuts.
- —How to use tangents, and full detailed information covering sky lights, scaffold and hoisting.

Guide No. 4—Over 448 pages—400 illustrations

- —How to put on wood, fibre and metal shingles.
- —How to lay gravel roofs.
- —How to lay tin roofs.
- —How to hang doors.
- —How to frame windows.
- —How to put on siding.
- —How to put on exterior trim.
- —How to do cornice work.
- —How to build stairs.
- —How to lath.
- —How to lay floors.
- —How to put on interior trim.
- —How to paint.
- —How to give first aid to the injured.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More Money Making Opportunities on pages 6 to 20

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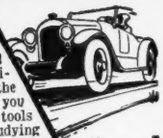

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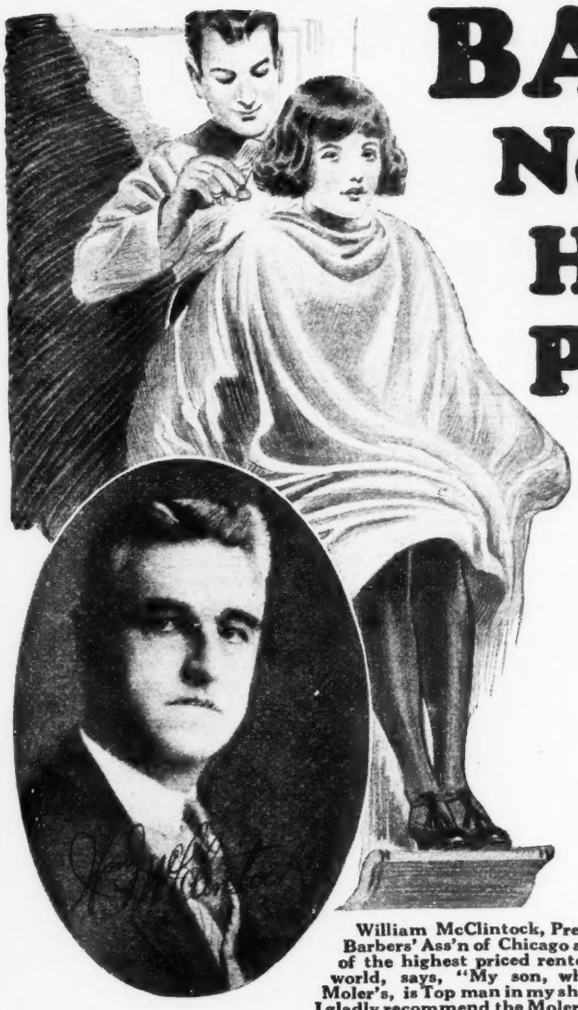

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More Money Making Opportunities on pages 6 to 20

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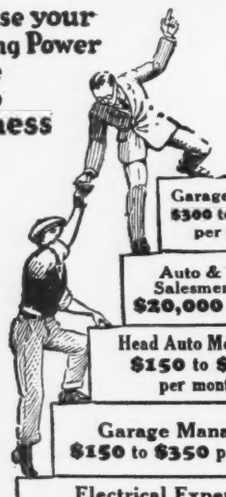

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More Money Making Opportunities on pages 6 to 20

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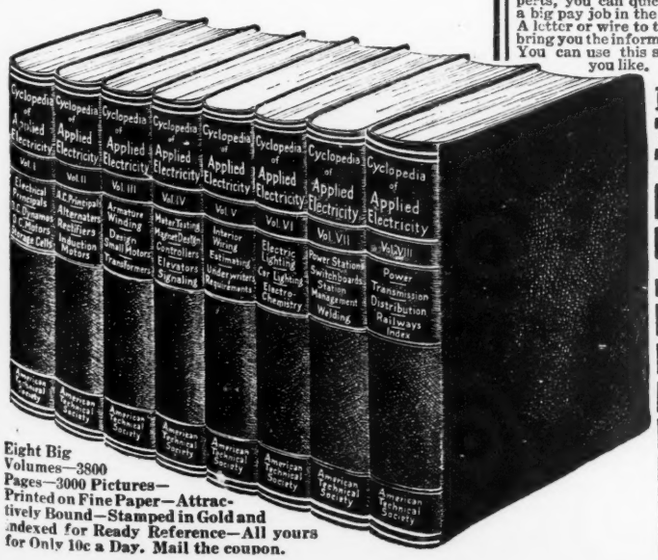

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More Money Making Opportunities on pages 6 to 20

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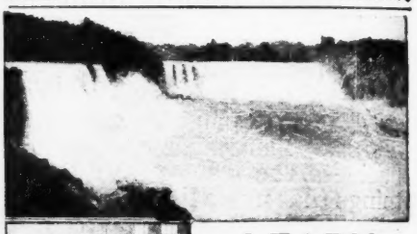

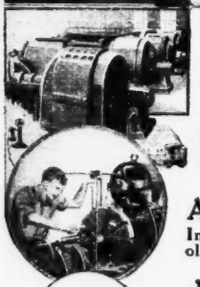

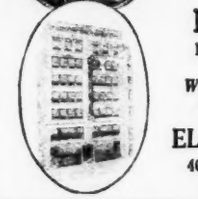

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15 Personal Engraved Christmas Cards $1.25, 30% Profit. Soliciting Folder 10c. Wolf, Printer, Lawndale, Philadelphia.

SALESMAN: If you think in terms of $6000 the first year write me personally. Strong line for retail stores. Nationally advertised. Established concern has unusual opportunity. Liberal weekly advance to producer. Geo. R. Williams, Mgr., 1922 Euclid Avenue, Cleveland, Ohio, Dept. 201.

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More Money Making Opportunities on pages 6 to 20

NERVE EXHAUSTION

How Nerve Abuse Wrecks Health

by PAUL von BOECKMANN

Lecturer and Author of numerous books and treatises on Mental and Physical Energy, Respiration, Psychology and Nerve Culture

THERE is but one malady more terrible than Nerve Exhaustion, and that is its kin, Insanity. Only those who have passed through a siege of Nerve Exhaustion can understand the true meaning of this statement. It is HELL; no other word can express it. At first, the victim is afraid he will die, and as it grips him deeper, he is afraid he will not die; so great is his mental torture. He becomes panic-stricken and irresolute. A sickening sensation of weakness and helplessness overcomes him, He becomes obsessed with the thought of self-destruction.

Nerve Exhaustion is due to nerve strain. There is no other cause for it. In men, nerve exhaustion can generally be traced to excesses and vices, although the strain of intense concentration and the worries of business life are often the chief factors. In women, Nerve Exhaustion is due mainly to over active emotions. Especially in their marital, domestic and kindred relations do women subject their emotions to constant upheavals. Indeed, we are all under severe nerve strain because of the mile-a-minute life we are leading. And no man or woman is so strong as to be immune to this strain.

Nerve Exhaustion is not a malady that comes suddenly, yet its symptoms are unmistakable. It does not manifest itself, as many think, in twitching muscles and trembling hands. The majority of sufferers from nerves seem strong and healthy, and may have not a tremor in their body, yet *inwardly* their nerves are in a turmoil and are undermining the entire bodily organism.

The symptoms of Nerve Exhaustion vary according to individual characteristics, but the development is usually as follows: First Stage: lack of energy and endurance; that "tired feeling." Second Stage: Nervousness; restlessness; sleeplessness, irritability; decline in sex force; loss of hair, nervous indigestion; sour stomach: gas in bowels; constipation; irregular heart; poor memory; lack of mental endurance; dizziness; headache; backache; neuritis, rheumatism, and other pains. Third Stage: Serious mental disturbances; fear, undue worry; melancholia; dangerous organic disturbances; suicidal tendencies; and in extreme cases, insanity.

If only a few of the symptoms mentioned apply to you, especially those indicating mental turmoil, you may be sure that your nerves are at fault—that you have exhausted your Nerve Force.

Perhaps you have chased from doctor to doctor seeking relief for a mysterious "something the matter with you." Each doctor tells you that there is nothing the matter with you; that every organ is perfect. But you know there is something the matter. You feel it, and you act it. You are tired, dizzy, cannot sleep, cannot digest your food, and you have pains here and there. You are told you are "run down," and need a rest. Your doctor may prescribe a drug—a nerve stimulant or sedative. Leave nerve tonics alone. It is like making a tired horse run by towing him behind an automobile.

And don't be deceived into believing that some magic system of physical exercise can restore the nerves. It may develop your muscle but it does so at the expense of the nerves, as thousands of athletes have learned through bitter experience.

The cure of weak and deranged nerves must have for its basis an understanding of how the nerves are affected by various abuses and strains. It demands an understanding of certain simple laws in mental and physical hygiene, mental control, relaxation, and how to develop immunity to the many strains of everyday life. Through the application of this knowledge, the most advanced case of Nerve Exhaustion can be corrected.

PAUL VON BOECKMANN

Author of Nerve Force and various other books on Health, Psychology, Breathing, Hygiene and kindred subjects, many of which have been translated into foreign languages.

I have made a life study of the mental and physical characteristics of nervous people, having treated more cases of "Nerves" during the past 25 years than any other man in the world (over 100,000 cases).

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This book will enable you to diagnose your troubles understandingly. The facts presented will prove a revelation to you and the advice will be of incalculable value whether you have had trouble with your nerves or not. Your nerves are the most precious possession you have. Through them you experience all that makes life worth living, for to be dull-nerved means to be dull-brained, insensible to the higher phases of life—love, moral courage, ambition, and temperament. The finer your brain is, the finer and more delicate is your nervous system, and the more imperative it is that you care for your nerves.

"Nerve Force" is not an advertisement of any treatment I may have to offer. This is proved by the fact that large corporations have bought and are buying this book from me by the hundreds and thousands for circulation among their employees—Efficiency. Physicians recommend the book to their patients—Health. Ministers recommend it from the pulpit—Nerve Control, Happiness. Never before has so great a mass of valuable information been presented in so few words. It will enable you to understand your Nerves, your Mind, your Emotions, and your Body. Over a million copies have been sold during the past fifteen years.

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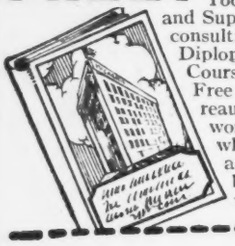

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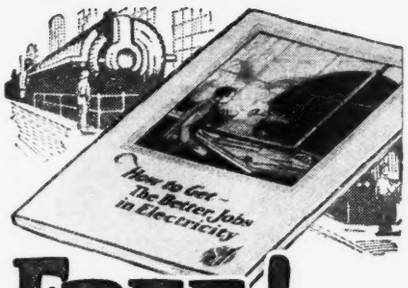

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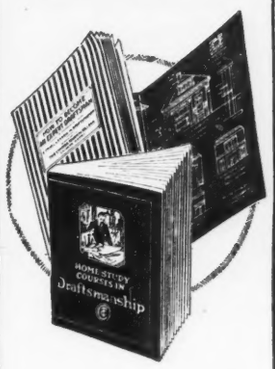

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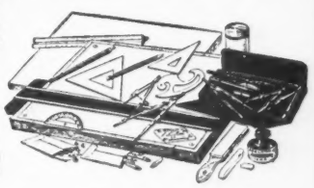

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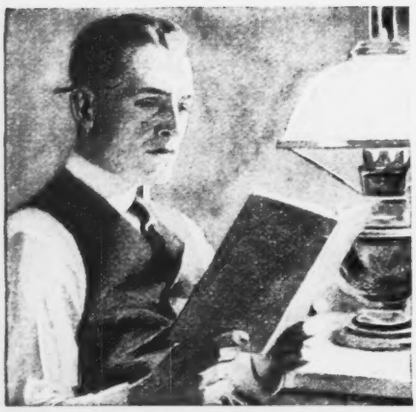

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More Money Making Opportunities on pages 6 to 18

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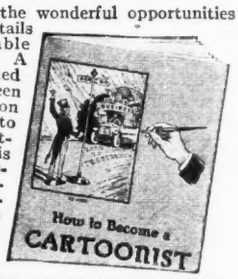

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If your radio set is equipped with navy type tube sockets, you can change to dry battery operation by inserting WD-12 Radiotrons. Ask your dealer for information as to how this can be done.

These are dry cell tubes—the tubes that made possible the swift progress of radio in the home everywhere. They meant clear tone—undistorted detection—radio and audio amplification—and volume reproduction — all with dry batteries. They meant radio in the city—on the farm—off in camp—everywhere!

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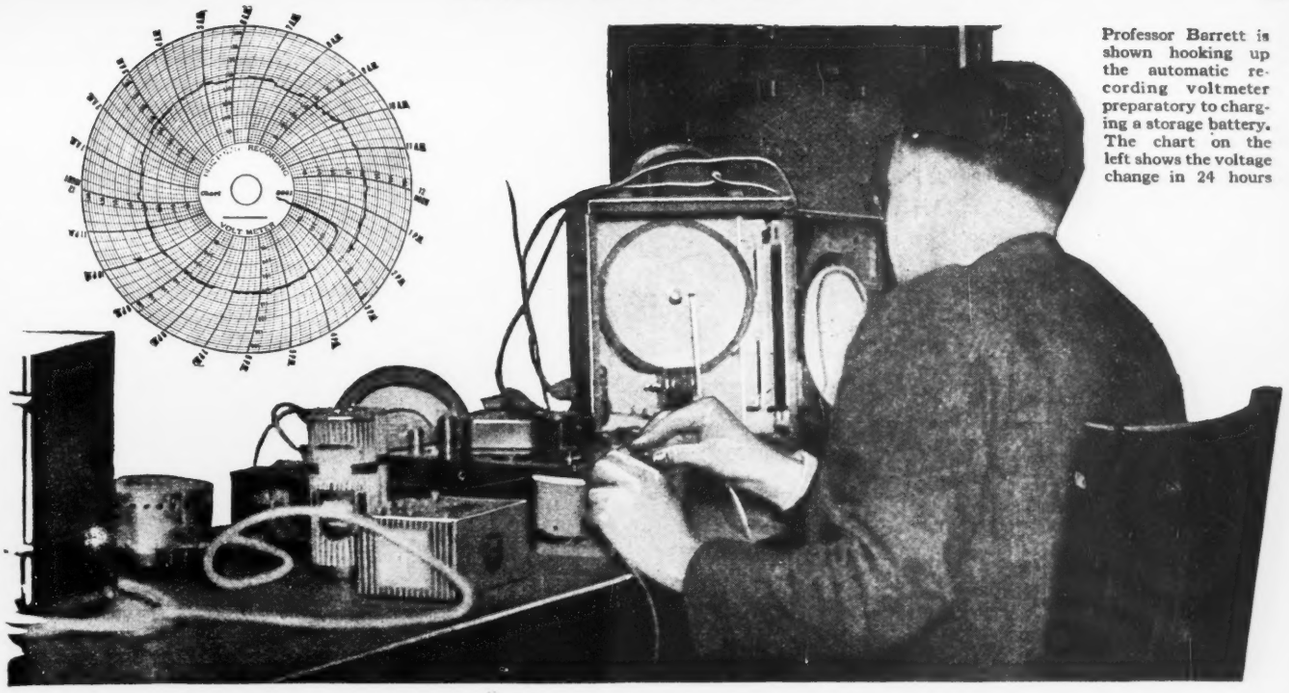

Professor Barrett is shown hooking up the automatic recording voltmeter preparatory to charging a storage battery. The chart on the left shows the voltage change in 24 hours

Testing Radio Storage Batteries

By Prof. Sampson K. Barrett

Engineer in charge of battery testing
Popular Science Institute of Standards

PROBABLY no piece of radio equipment has its vital parts more completely hidden than a storage battery. In looks, there is no appreciable difference between a 10- and a five-dollar battery. The difference is in the plates, and there is but a small hole through which to examine them. The engineers of the Popular Science Institute of Standards examine these plates *by observing the functioning of a battery during charging and discharging.*

Three things must be investigated to determine the value of a battery—the ampere-hour rating; the life in cycles; the ability to retain a charge.

After a thorough inspection, the specific gravity of the electrolyte in the cells is measured. Presumably, when bought, a battery should be in a state of charge. It must be remembered that all manufacturers do not charge their batteries with an electrolyte of the same specific gravity. Many batteries are completely charged when the hydrometer reads 1.200; others run as high as 1.300. In general, one will find batteries completely charged at 1.275. Our engineers compare the figures obtained on this specific gravity test with the claims of the manufacturer to determine the state of charge from which to start the test.

Then the battery is discharged by utilizing load rheostats until it reads 5¼ volts—for a six-volt battery. The specific gravity is read and that becomes the lower discharge limit. The battery is again charged and readings are taken at intervals to determine the number of ampere hours required to return the battery to its maximum charged condition. When the voltage ceases to rise, the battery is considered charged and specific gravity is again measured. This determines the upper range of specific gravity for this type of battery and that is compared with the manufacturer's claim.

Once more the battery is discharged and the ratio of ampere hours taken out of the battery to those previously put in when the battery was charged gives its efficiency, which should range from 85 to 95 per cent. Batteries increase in efficiency for the first few cycles, usually arriving at the maximum at the seventh cycle. If a radio battery is less than 80 per cent efficient at the fiftieth cycle, the Institute of Standards disapproves it.

Probably the thing that interests radio fans most in a storage battery is its ability to retain a charge. After the above tests, the battery is charged and allowed to stand idle, being tested every few days. The minimum requirement is that a battery shall not exceed two per cent of self-discharge every day. A good battery will still show 80 per cent of its initial capacity after three months.

It is obvious that a battery standing up under the severe tests detailed above *must* give satisfaction. A purchaser will do well to use batteries approved by the Institute of Standards.

It is obviously impractical for even as completely organized a bureau as the Institute of Standards to test all products listed in tool or radio catalogues advertised in our columns. Only tool and radio products *specifically* advertised in POPULAR SCIENCE MONTHLY are tested and approved by the Institute.

Send for list of Approved Products

POPULAR SCIENCE MONTHLY will be glad to furnish, upon request, a list of Radio and Tool Manufacturers whose products have been tested and approved by the Institute.

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The above seal on an advertisement indicates that the products referred to have been approved after test by the Popular Science Institute of Standards.

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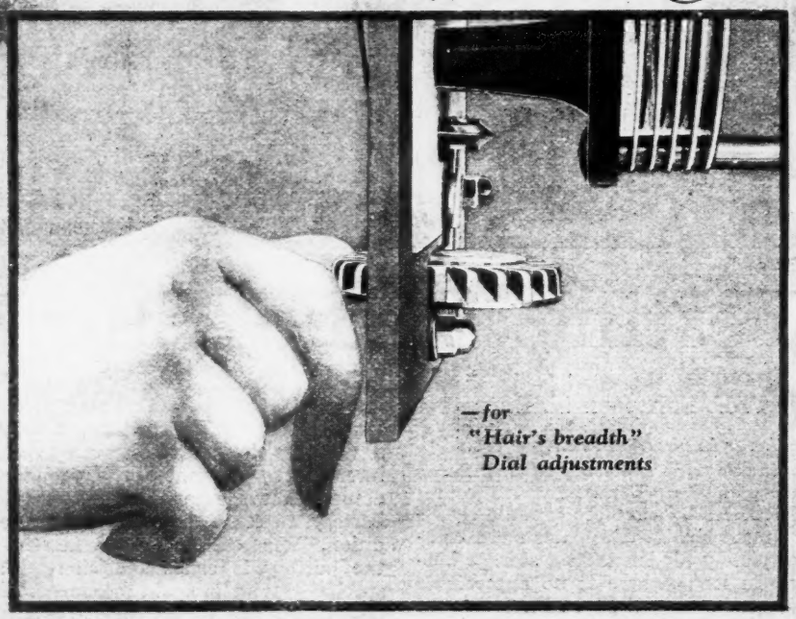

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—*Confucius*

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POPULAR SCIENCE MONTHLY
SUMNER N. BLOSSOM, Editor
September, 1924

Drawn for Popular Science Monthly by Scriven Bolton, F.R.A.S.

If the Exploding Mira Ceti Were Our Sun

By Scriven Bolton, F.R.A.S.

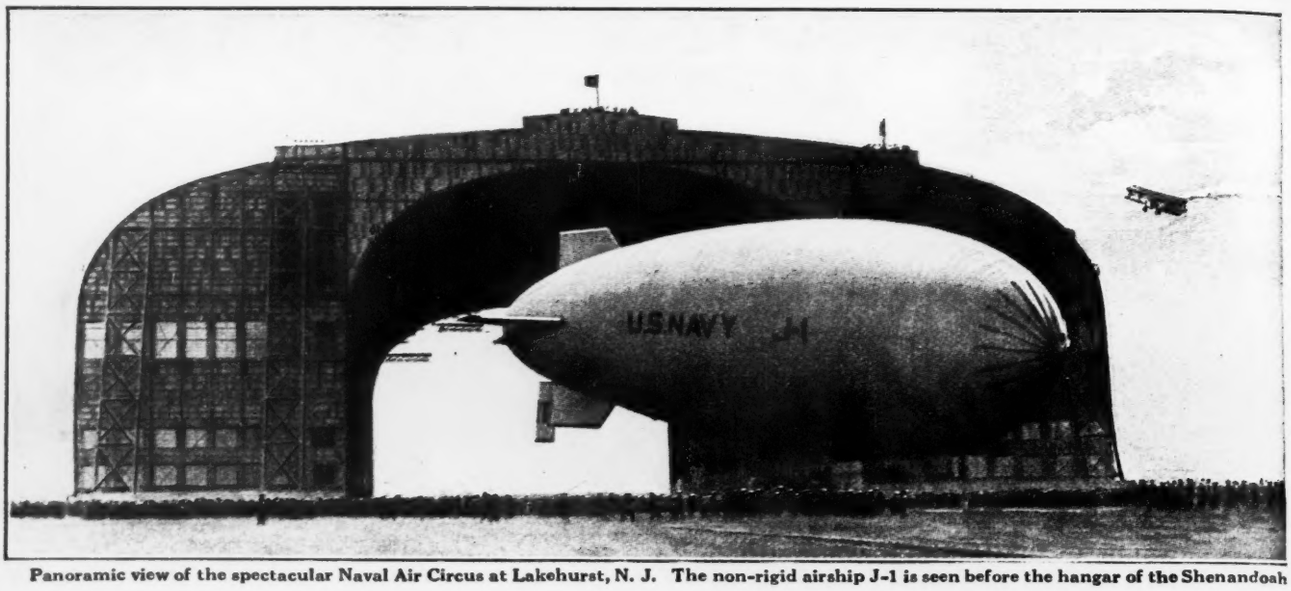
SUPPOSE our earth, instead of being governed by the sun, were a planet of a giant exploding star that, in occasional eruptions, threw out 20 times as much heat as the sun. What would happen to us?

I have drawn here an imaginative picture of how our world might appear under such conditions. It was suggested by a recent mysterious revival in the brightness of the great dying red star Mira Ceti, in the constellation Whale. One explanation of this brightness is that a crust is beginning to form on the surface of the star as it cools. Pressure becomes so great that violent explosions frequently occur, and the light and heat emitted is increased many times.

Mira Ceti is dying down rapidly, and now is not as hot as the sun. Yet it is so vastly superior in size that if we were as near to it as we are to the sun, our globe would be a red-hot, lifeless mass, without atmosphere or oceans.

The heat emitted by the star after every explosion would approximate 1000° F. at the earth's surface. Metals with comparatively low melting points, such as tin, lead, and bronze, would flow like water. The terrible bombardment of poisonous gases would make life impossible.

Mira Ceti is a star of the older type. It appears to have a gaseo-liquid interior; not wholly gaseous, as the younger suns. The spectroscope tells us that its atmospheric layers are composed chiefly of hydrogen and titanium oxide.



Panoramic view of the spectacular Naval Air Circus at Lakehurst, N. J. The non-rigid airship J-1 is seen before the hangar of the Shenandoah

Sky Sports of Tomorrow

By Lieut.-Comm. Fitzhugh Green, U.S.N.

ATHLETIC contests and other forms of sport are being literally crowded off the earth.

Last year 303,430 people attended the World's Series. Football stadiums holding 100,000 spectators are being built in various parts of the country. Larger swimming beaches, larger gymnasiums, more numerous golf links and tennis courts are being put into commission as rapidly as money and labor are available.

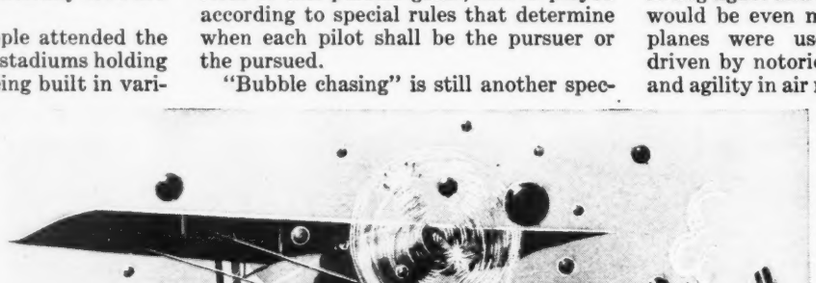
But the crowding always seems to be just ahead of the building. It is practically impossible to attend a modern contest that has been widely advertised without a disagreeable preliminary battle for parking space and tickets.

A fascinating solution of this vital national problem is suggested by the sudden entrance of aeronautics this year into the field of safe and sane sports and pastimes.

This development is coming from two directions: first, the "baby balloon" used as a sort of life-preserver to carry its wearer into the free and uncrowded sky; and second, the commercial dirigible reduced to taxi size for family use. Both types have been studied at our naval air base at Lakehurst, N. J., and at Mitchel Field, L. I., of the United States Army.

The first signs of this novel outgrowth from military aviation came in the form of "dog-fighting," "bubble-chasing," and "aerial tag." A "dog fight" with planes was simply a mock duel between two high-speed combat machines thrillingly maneuvered by stunt fliers. Lieutenant A. L. Williams, the navy pilot, who won the Pulitzer Prize last year with a speed of 266 miles an hour, probably is the world's best "sky terrier." "Aerial tag" is another form of this pursuit game, and is played according to special rules that determine when each pilot shall be the pursuer or the pursued.

"Bubble chasing" is still another spectacular game with planes. A number of small free balloons of various colors are released. Each pilot in the air chases his own color, seeking to destroy the drifting bright-hued rubber bubbles by diving into them with his whirring propeller blades.



Bubble-chasing — one of the most thrilling of the earliest air sports

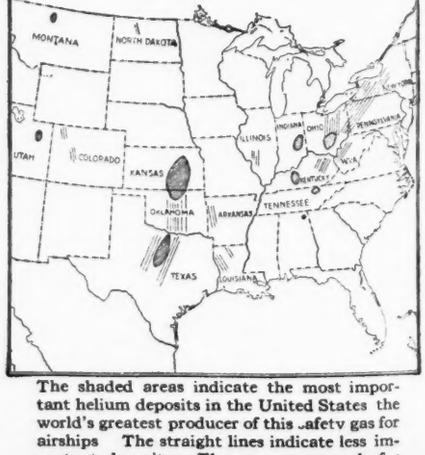
Each pilot seeks to destroy small balloons of his chosen color by diving into them with the plane

OF COURSE such performances are replete with thrills. They represent the most blood-chilling form of aerial acrobatics. The men engaged in them risk their lives every moment of the game.

But, to the surprise of the authorities, the popularity of all these aerial demonstrations seemed to center not on the dangers that beset the intrepid birdmen, but upon the spirit of competition involved. Acting on this cue, our experts at once began developing an entirely new technique. Projected into the future, the novel forms of flying they have achieved may revolutionize our modern ideas of sports and athletic contests.

For instance, it was soon seen that both in dog fights and in bubble chases a crowd would be even more enthusiastic if slow planes were used rather than racers driven by notorious speed demons. Skill and agility in air maneuvers proved, in the long run, more alluring to human interest than hair-raising stunts, which soon palled after the first excitement had worn off. As a result, the percentage of accidents in such entertainments soon was reduced to almost zero.

FROM this form of aerial sport the next step was a logical one. When it was seen that people wanted competition between the entries, combined with safety of the entrants, "parachute racing" was



The shaded areas indicate the most important helium deposits in the United States the world's greatest producer of this safety gas for airships The straight lines indicate less important deposits. The map was made for this magazine by R. B. Moore, D.Sc., former chief chemist, U. S. Bureau of Mines

Beyond the great crowd of spectators, is the giant navy dirigible Shenandoah at her mooring-mast. At right is a jumping balloon

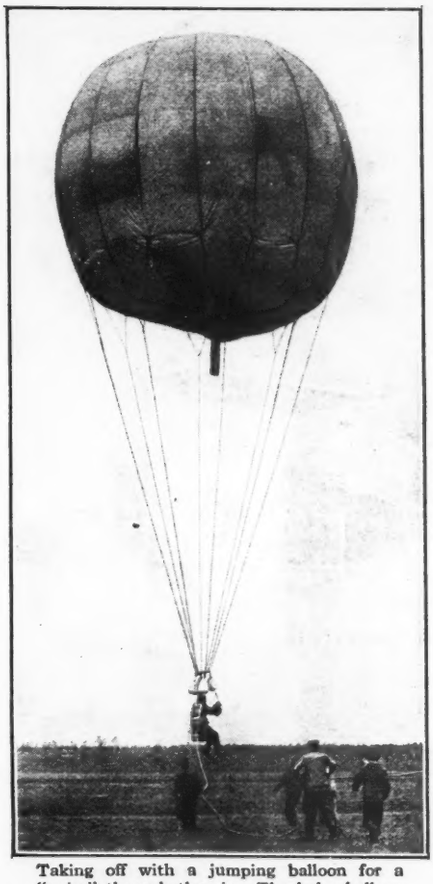
devised. Several parachute jumpers were sent up in slow planes or captive balloons. At a given signal all dropped at once.

OF COURSE, in this form of contest the speed of falling is beyond control of the jumper unless he is given control of his parachute's apex vent. But this dangerous expedient is rarely resorted to save in an emergency, such as when approaching open water. So the result of a parachute race is left to the caprice of local meteorological conditions. Vertical currents of air are the determining factors. By having colored parachutes or distinctive suits for the airmen, their performances can be wagered upon just as if they were jockeys.

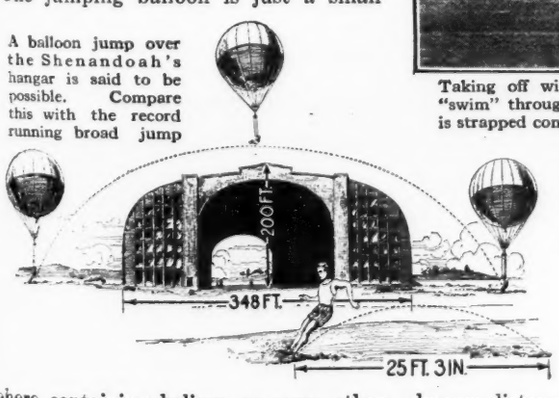
But the parachute game hasn't met with any wide enthusiasm, chiefly because it lacks the element of human competition based on man's individual effort. Hence, this summer the "jumping balloon" was brought into favor.

As was suggested above, the principle of a jumping or baby balloon is similar to that of a life-preserver. But with air as the swimming medium it is necessary to add relatively more buoyancy to the swimmer than in water. The reason is that the weight of air displaced by one's body is far less than that of the same volume of water.

The jumping balloon is just a small sphere containing helium or some other gas considerably lighter than air. Helium is particularly convenient because it is non-flammable, and so permits the "swimmer" to smoke if he or she desires. The balloon is strapped comfortably on the back with broad bands running under the armpits and chest.



Taking off with a jumping balloon for a "swim" through the air. The baby balloon is strapped comfortably to the jumper's back



A balloon jump over the Shenandoah's hangar is said to be possible. Compare this with the record running broad jump

It is necessary, of course, that a negative to buoyancy always exists or the jumper is in danger of helplessly leaving *terra firma* for a haphazard ride of unknown distance in the air. But with only a few ounces of negative buoyancy a man can perform astonishing feats.

Take the athlete who can jump, say, 24 feet. By reducing his weight 1000 times or so, theoretically he could jump about half a mile! As a matter of reality, though, he would find that the awkward size of his "air preserver" would prevent his getting any sort of take-off. Yet one of the navy gang at Lakehurst has vowed that before he leaves the station he will, by this means, jump over the huge hangar of the dirigible *Shenandoah*, which is 348 feet wide and 200 feet high!

It is at this point that we enter the broad realm of future air sports. For if one's body can be made as light as a feather, one may jump and swim and float in the air as we now do in the sea.

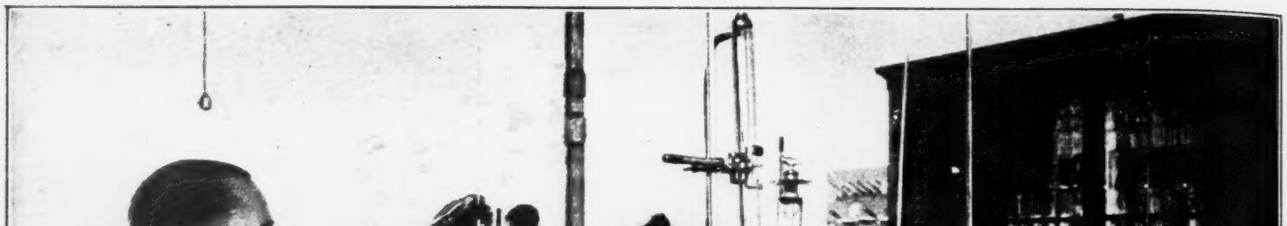
Certainly there is need for something of the sort. Take conditions at Coney Island. Of course that resort is near a big city and is more crowded than most beaches. But many others will soon be as congested. Not so long ago a man who was toppled over by a big wave knocked two teeth out by striking a stranger's knee on one side of him, while his flying heel delivered a French Kayo to an unsuspecting lady on the other. Obviously, there simply wasn't room to swim. Whereas had the same Sunday multitude been cavorting *above* the ocean at that point, there would have been comfortable space for a thousand times the same number of holidayites.

"AIR beaches" soon will be a reality. The skies above large city parks would provide areas. Of course, "life lines" will have to be strung. On an ocean beach there are buoyed ropes. On an air beach there will be light nets dangling from captive balloons so that the air swimmer will not be blown adrift across the city.

The expense will not be very great. Balloons will be hired, fitted, and worn as roller skates or bathing-suits are now. And, best of all, no risks will be taken. The balloon will be locked on by an attendant so that the wearer cannot escape even if he should try.

Another form of air sport is rapidly evolving from the taxi style of dirigible. The French recently have designed and built what they call the "Vedette." This is an airship that has the same relation to big fellows like the ZR-1 as a trim roadster has to a bulky truck.

(*Continued on page 125*)



Mr. Gardner in his laboratory, where every kind of paint and varnish is subjected to the severest scientific tests

What Paint Means in Your Life

An interview with **Henry A. Gardner,** *Director of the Institute of Paint and Varnish Research at Washington*

By Edward Mott Woolley

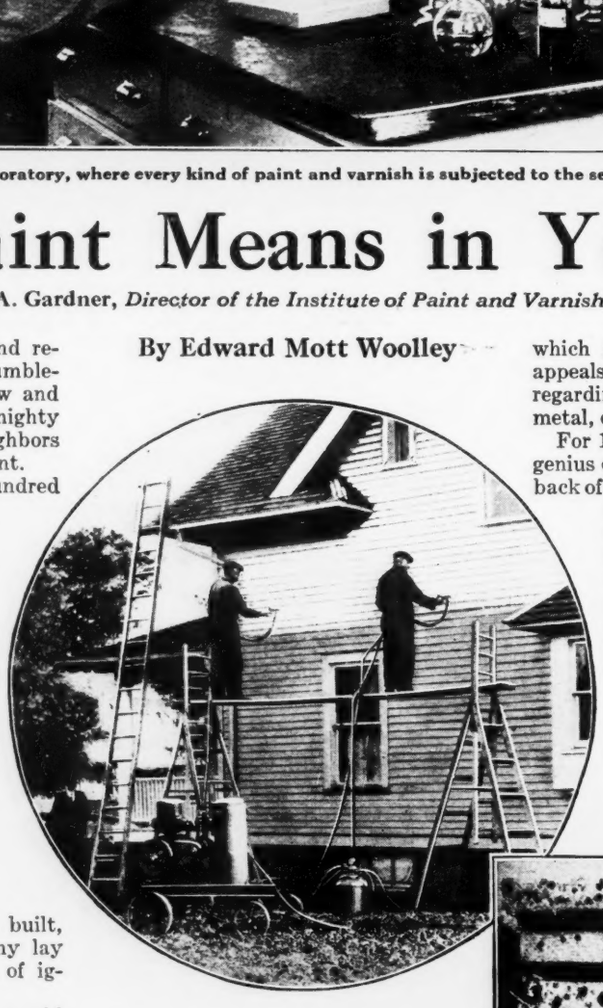
WHILE touring New England recently I came upon a tumbledown barn, its roof hollow and broken, siding ragged, and its mighty beams awry and crumbling. Neighbors testified that it had never seen paint.

Just beyond was a barn a hundred years older that still stood square and unbroken. It had outlived successive owners, and the secret of its longevity was simply paint and more paint.

But the secret of paint is another story. In fact, paint has innumerable secrets, many still unlocked. Within the last decade or two, scientists have been searching chemistry for the keys to paint mysteries, and have opened the doors into paint and varnish knowledge that previously were quite unsuspected. The scope of the preservative art has been extended in a hundred directions. In the days when those New England barns were built, paint was just paint. Its alchemy lay deeply concealed under a burden of ignorance.

Today the paint put on a barn would not be used on the deck of a ship; and the paint on the deck would be of no value on the ship's bottom. Nor would the paint on the ship's bottom be of use in painting an acid-manufacturing plant. We might go on with these comparisons, and only touch the high lights of paint research.

Indeed, research has thrown the searchlight into tunnels of paint usage hitherto undreamed of. It was never known, for instance, that paint might have a pronounced effect on acoustics, human growth, and plant life. Nor was it realized that the color of paint could affect materially the radiation from a steam-heating plant or the evaporation from a tank of naphtha or gasoline.



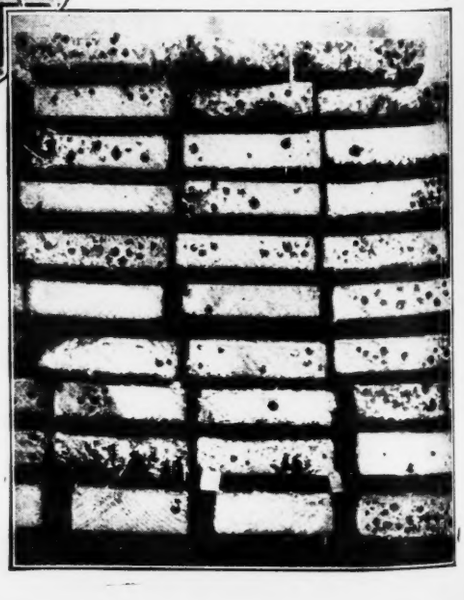
Ever since large chemical factories came into existence, the bane of the adjacent house-owner has been the discoloration of the paint on his home —for which there seemed no remedy.

Retarding the work of fire, branding cattle, disinfecting, fighting off the barnacle and toredo in salt water —these now are the duties of paint. Paint research has set in motion new industries that concern not only pigments and chemicals, but horticultural activities as well.

To get the essence of the progress I went to Washington and talked with Henry A. Gardner at the Institute of Paint and Varnish Research, which for years has been the focus of appeals by the paint and color industry regarding the secrets of preserving wood, metal, cement stone, and other materials.

For 15 years Mr. Gardner has been the genius of the paint industry, which stands back of this research organization. I found, near the War Department, a paint laboratory of extensive ramifications. There were optical and other physical instruments and devices highly scientific, a miniature paint, color, and varnish factory, and numerous rooms filled with chemical paraphernalia

With the pneumatic sprayer one man now can do the work of five using the hand brush. Below: Tests showing effects of toredo on wood uncoated and coated with experimental paints and submerged six months in ocean. Unpainted planks are badly pitted



—such as colorimeters, refractometers, spectrophotometers, and viscometers. There were rabbits and guinea pigs for physiological and psychological tests of colors, and no end of mechanisms and methods for testing the performance of paint materials.

"I FOUND, however, that the laboratory was merely the pivot on which revolved activities extending over the continent and beyond—on the land, underground, and in the water. Few consumers of colors, paints, and varnishes know what the scientists are doing to improve these products and to find new paints and varnishes for checking the ravages of nature. The paint scientist must have at least a working knowledge, not only of chemistry but of bacteriology, biology, botany, physics, pathology, and other sciences, for all these have been applied to problems confronting the industry.

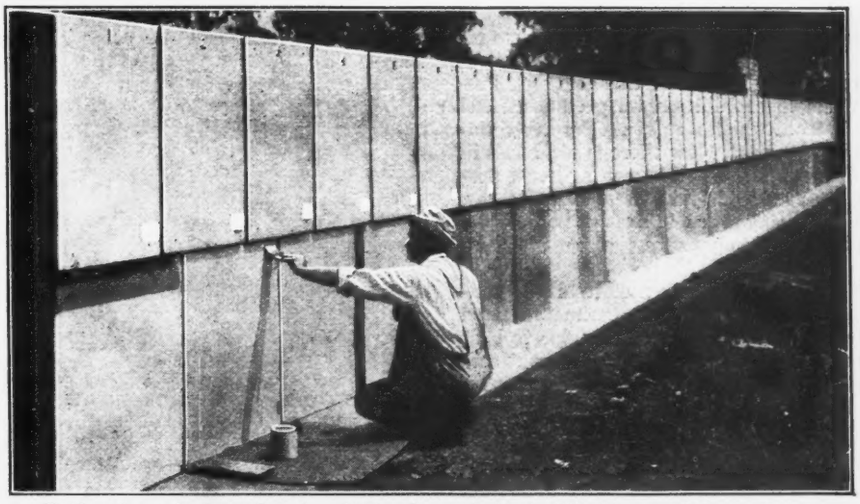
"In recent years especially," said Mr. Gardner, "the paint chemist has made many discoveries to extend the use of preservative coatings. New pigments and colors are now in use, helping to meet the demand for paints, thus taking some of the burden from white lead. That these developments are necessary is indicated by the fact that demands on the metal lead may make the supply for paint insufficient.

"Whenever a need for a new paint has manifested itself, the chemist used his imagination, first to conceive the possibility of such a paint, and then through scientific research to develop it.

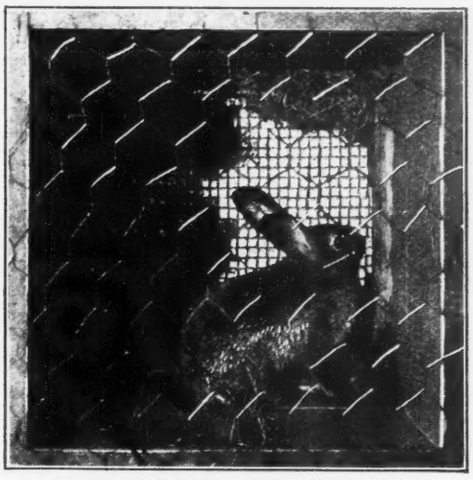
"Fifteen years ago scarcely a dozen paint factories had chemists. Now practically all of our 300-odd manufacturing plants use them. One factory alone has more than 80 technically trained men in the laboratories and plant. In the last 10 years the paint industry has grown in value from $200,000,000 to over $400,000,000 a year.

"In the days when any paint was used for any surface," Mr. Gardner continued, "people who lived in factory or mining cities found the paint on their houses turning black from chemical fumes. It was discouraging to paint anything white, and even light colors soon became streaked and sooty.

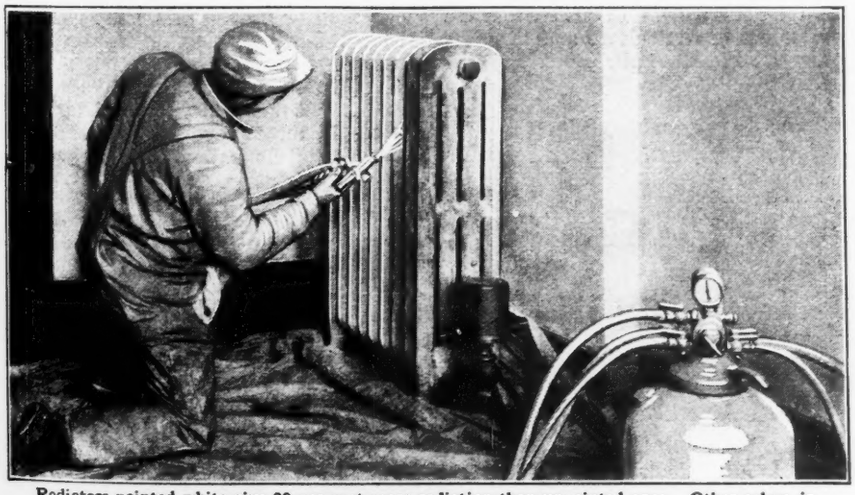
"House-owners were in despair. But meanwhile research went on, and today we have paints that remain unchanged in atmospheres of hydrogen sulphide and similar gases. One of these paints is made from a white pigment now produced from titanium ores, a large quantity of which is found on the sands of the Florida beaches. Tests made on houses where an abnormally high percentage of hydrogen sulphide is present have shown very white surfaces and great durability for several years.



Testing the endurance of various kinds of paint on concrete surfaces. Similar tests have been made on cloth, steel, wood, and other materials in different parts of the country to determine the proper paint to use under varying climatic and wearing conditions



In light colored cages animals grow rapidly, while dark paint retards them. Note how this rabbit is attracted to the light spot



Radiators painted white give 20 per cent more radiation than unpainted ones. Other colors in order of their radiation values are cream, red, green, yellow, black, aluminum, and brown

"ANOTHER development that has brought about an entirely new vogue in interior decoration in houses and factories is the large-scale production of lithopone, one of the newer white pigments. In 1907 lithopone was being introduced gradually to the paint trade. Combined with Chinese wood oil varnishes, manufacturers were able to place on the market coatings of great hiding power and extreme whiteness. This marked the beginning of a nation-wide fashion for painted walls, and today it is the custom in hospitals, hotels, apartment houses, and many public buildings to use paint upon wall and ceiling surfaces. In factories the amount of electric current saved through the use of modern, sanitary, light reflecting paints has more than balanced the cost of the paints and their application. Over 100,000 tons of lithopone is now used annually in the United States.

"Another white pigment that the paint-grinder could not do without is zinc oxide —the whitest pigment produced. Its use in interior enamels and as a component of exterior paints are its chief applications.

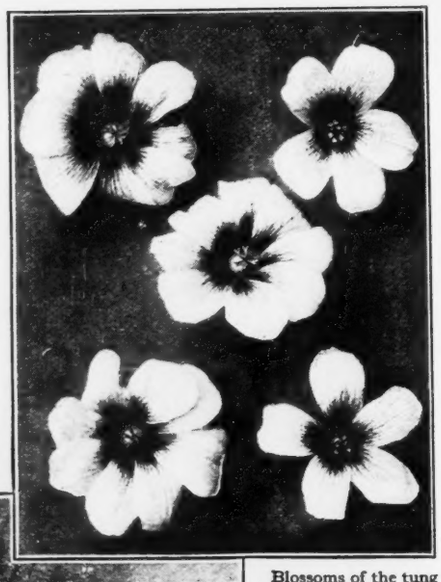
"The development of paints for acid-manufacturing plants, packing-houses, iron beams of smelters, pipe lines, underground timbers in mines, and similar structures all form stories of interest. The necessity for special paints has thus built up the ready-mixed paint industry. Hundreds of tests are made before the formulas for these paints are finally adopted."

Recent accomplishments in the painting of metal, especially adaptable to the automobile, were explained by Mr. Gardner:

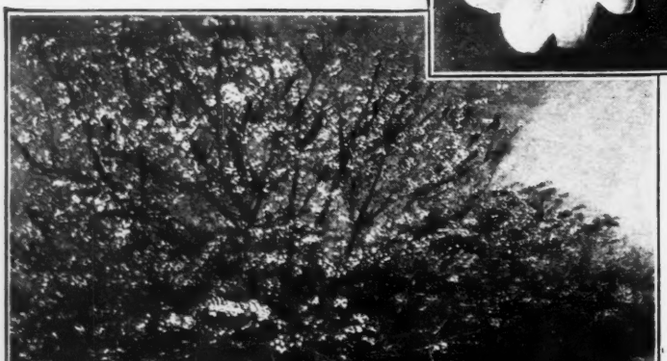
"The automobile industry has been largely dependent on vegetable oils for desirable coatings, but now, through an adaptation of guncotton, a new type coating has been developed in the industry. It will not replace the old high gloss varnish finish, but will be used indefinitely for special purposes. We grow the bulk

of the world's cotton and we get nitric acid from the air—the two products required for the production of nitro-cellulose, the base of this coating. Previous to prohibition we produced fusel oil, from which a solvent for nitro-cellulose is made. Now there is produced in America a solvent known as butyl acetate, used widely in these new finishes. For coating wood it has not reached its ultimate development.

"REVERTING to metal paint in general, extensive experiments have been made to discover formulas to best protect iron and steel. In different sections of the United States we have set up series of painted metal panels for long periods. Many of these were exposed on Young's Million Dollar-Pier in Atlantic City. The application of principles thus learned, means an annual protection from rust of several million dollars.



Blossoms of the tung tree, now grown in Florida for the oil in its nuts. This oil is the basis of many waterproof varnishes



A tung tree in bloom. Large acreages have been cleared for tung seedlings. These promise to rival the grapefruit and orange trees

"Field tests have also been made with steel fence wire, cement structures, shingle roofs, and metal and wood roofs in varying climatic conditions."

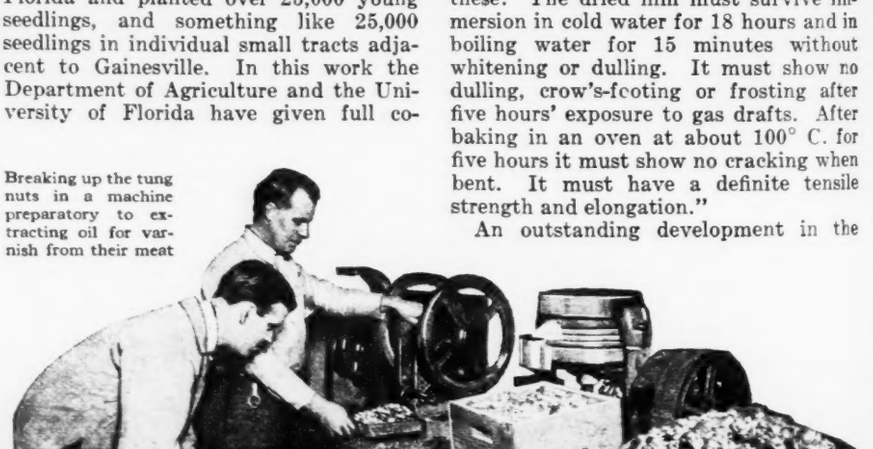
My conversation with Mr. Gardner turned to the scarcity of drying oils and the growing demand for them. And here he told me about a wholly new industry, which paint research has brought to America.

"IN RECENT years," he said, "Chinese wood oil or tung oil has been most important as the basis of practically all waterproof varnishes. During the last two years the price, normally about one dollar a gallon, rose to over four dollars, and even at that most of the oil was adulterated.

"The Department of Agriculture, however, had brought over a few of the tung nuts about 12 years ago, and planted them in a few Southern States. I visited these places on several occasions during the last few years. Among them were 10 trees planted at the University of Florida, on the grounds of the State Agricultural College at Gainesville—some 50 miles southwest of Jacksonville. These trees are fully as vigorous as any in China. The growing of sufficient trees to produce the oil for America was then brought to the attention of the Educational Bureau of the Paint and Varnish Manufacturers' Associations. At a recent convention a fund was subscribed to start an American tung-oil industry.

"Fortunately, the year before a large quantity of nuts from Florida had been planted in a small nursery, and over 100,000 seedlings were produced. During the last three months we have cleared large acreages in northern Florida and planted over 25,000 young seedlings, and something like 25,000 seedlings in individual small tracts adjacent to Gainesville. In this work the Department of Agriculture and the University of Florida have given full co-operation to members of this Institute.

Breaking up the tung nuts in a machine preparatory to extracting oil for varnish from their meat



"This is of great interest to northern Florida agriculturists, as frost played havoc with citrus fruits there. Peanuts and cotton largely constitute the agricultural pursuits in that region, and do not average over $20 yield an acre. It would appear that the tung-nut tree, properly cultivated, will be the salvation of northern Florida, and that within a few years there may be sufficient groves planted to meet fully the requirements of the American varnish industry. The oil from the Florida nuts is superior to that from China. We have a large nursery at Gainesville, where we are growing seedlings for dissemination to agriculturists throughout the northern part of the State.

"In a similar way our Educational Bureau has inaugurated much work in the Northern States, where flax is raised for linseed oil. The study of flax diseases, soil conditions, methods of planting and harvesting, crop rotation, and so on, have been carried on in a scientific manner. In all this work the State Colleges of Agriculture in North and South Dakota have cooperated.

"THE industry is always on the watch for newer paint oils and resins, and far parts of the world have been scoured. We have investigated the oils from many species of nut-bearing trees and seed plants in Japan, China, the Philippines, Australia, Mexico, and other foreign countries; the oils from the waste raisin seed of California, from the soya bean—now grown quite widely in America—from the chia plant of the Southwest, from a dozen different sea animals, and from other sources. Many of these have good drying properties and are applied to a limited extent."

The story of varnish is quite as interesting in many respects as that of paint. Continued research has built up almost unbelievable qualities in varnish coatings.

"Few consumers have any notion of the grueling trials that modern, high-grade varnish must withstand," Mr. Gardner explained. "Some of the tests for standardized water-resisting spar varnish are these: The dried film must survive immersion in cold water for 18 hours and in boiling water for 15 minutes without whitening or dulling. It must show no dulling, crow's-footing or frosting after five hours' exposure to gas drafts. After baking in an oven at about 100° C. for five hours it must show no cracking when bent. It must have a definite tensile strength and elongation."

An outstanding development in the paint industry was the coming of the spray machine, which completely uprooted traditional methods of painting in factories. In automobile plants especially, spraying has almost superseded the hand brush.

(*Continued on page 126*)

"Do It Right if It Takes a Year"

The Story of How Ambrose Swasey Made Possible Some of the Wonders of Modern Astronomy

By George Appel

A FEW weeks ago a short, broad-shouldered, active man with snow-white hair and pointed white beard, whose personality suggested unmistakable evidence of eminence, stood on a platform in the Engineering Societies Building in New York City to receive the John Fritz Gold Medal. The award of this medal is probably the most distinguished honor that can be paid to an engineer, for since the medal was instituted in 1902 and presented to the father of the modern rolling mill whose name it bears, its recipients have included such men as Edison, Lord Kelvin, Sir William White, Westinghouse, Alexander Graham Bell, Marconi, Alfred Noble, Elihu Thomson and Orville Wright.

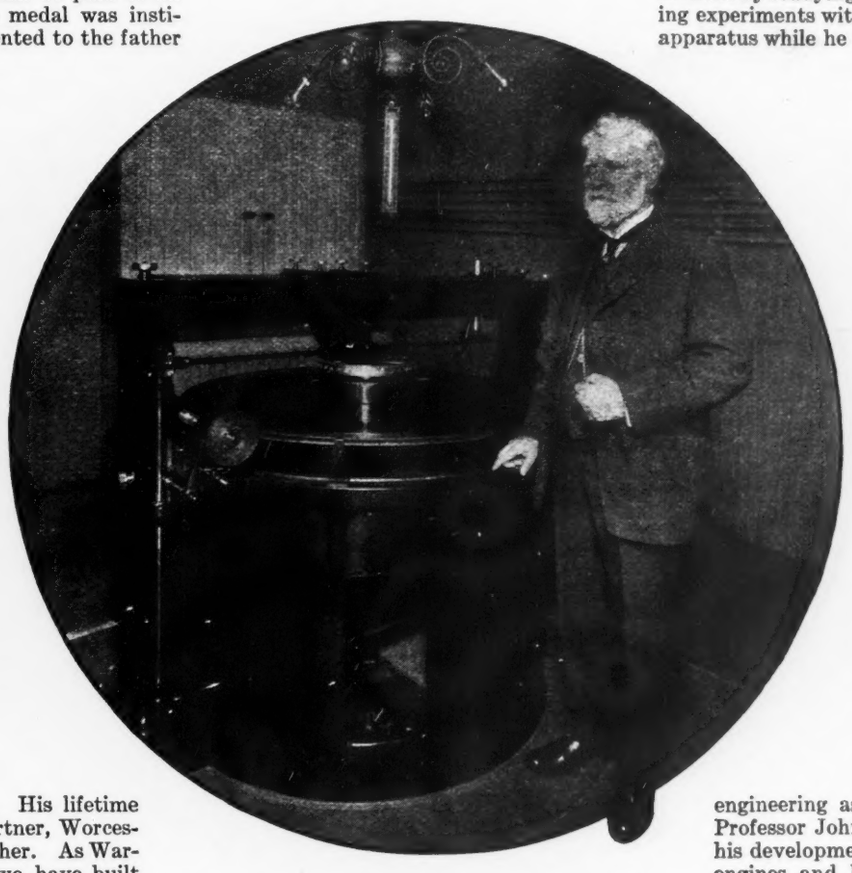
THIS man's name is Ambrose Swasey. Observing his brisk, alert movements, and hearing the full, rounded tones of his voice, one would say that he was just passing beyond middle life—that he was 60, possibly. As a matter of fact, he is in his seventy-eighth year, having been born in Exeter, N. H., in 1846.

He is one of the world's foremost builders of telescopes. His lifetime friend and business partner, Worcester R. Warner, is the other. As Warner & Swasey these two have built most of the world-famous modern giant telescopes, beginning with the noted Lick instrument, the construction of which, almost 40 years ago, marked an epoch in the new astronomy just as surely as the telescope of Galileo did in the old. Most refracting telescopes built in modern times have been practically copies of that first-fruit of the genius of Warner & Swasey, without which, as a noted astronomer wrote recently, modern astronomy would have been impossible.

Not only in the construction of great telescopes, but in the invention and manufacture of machine tools, this company has achieved international fame. Its machines are used today by leading manufacturers throughout the world.

It was because of the contributions he has made to science and engineering and his benefactions to education through the Engineering Foundation that he established in 1914, that Doctor Swasey—he is a doctor of science, a doctor of engineering, and a doctor of laws—received the Fritz Medal.

A day or so after his return from New York, I called on Doctor Swasey at the factory of The Warner & Swasey Company, in Cleveland, Ohio. My purpose was to get him to talk about himself. But, were I dependent for information about Ambrose Swasey on what I heard from his own lips, my visit would have been signally disappointing. He will talk with spontaneous enthusiasm about his work, for he loves it. He will discuss astronomy, architecture, and other widely diverse subjects in which he is interested. But when asked to speak about himself, his conversation lags, and he shows unmistakable signs of being bored.



Alert and active at the age of 78, and with a passion for accuracy, Ambrose Swasey recently won probably the highest honor that can be paid to an engineer—the John Fritz Gold Medal. Here he is standing beside one of his marvelous precision instruments, a dividing engine for graduating circles into degrees and minutes. It is so accurate that if the circle were six miles in diameter, no division would be more than an inch out of place

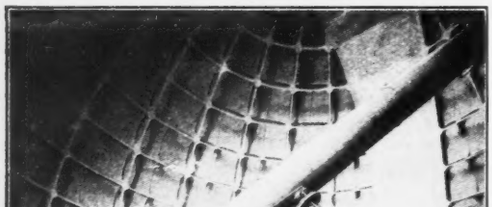
It was not he, but one of his associates, who told me that his philanthropies run into large sums; that he has given more than a half-million dollars to the Engineering Foundation alone. Neither was it he who told me that the establishment of the school for apprentices in the Warner & Swasey factory, in which the boys and young men who enter the employ of the concern are given a thorough training in engineering at the company's expense, was largely the result of Doctor Swasey's memory of his own experiences as an apprentice boy. Nor did he tell me how as an apprentice he acquired knowledge of many sciences by studying at night and performing experiments with homemade scientific apparatus while he was learning his trade.

And it was not Doctor Swasey who told me that while he was a young machinist in a New England shop he solved two problems that had been bothering machinists for years. He devised a milling machine to produce gear cutters that would give to gear teeth the true epicycloidal curves. Later he invented a gear-cutting machine for generating and at the same time cutting the teeth of spur gears.

NEITHER was it he who told me that when he was a machine-shop foreman at 33, Cornell University sought to persuade him to join its faculty in the department of mechanical engineering as successor to the late Professor John E. Sweet, famous for his development of high-speed steam engines and himself a Fritz Medal winner 10 years ago.

Doctor Swasey did tell me, though, that when Worcester R. Warner, now his partner, came to the Exeter Machine Works as an apprentice, it marked the turning-point of his life. That was in 1865, when each of them was 19. Until then, Swasey's nightly study of the sciences had not included astronomy. Warner, though, had some knowledge and great interest in astronomy, and Swasey caught his enthusiasm. They studied astronomy together, and years later—in 1880, when they had combined their joint savings of $5000 and embarked in business together as manufacturers of machine tools—they decided to build telescopes as a side line.

The making of telescope mountings still remains a side line with them. But it is indeed an extraordinary avocation that has given to science such great instruments



The world-famous 36-inch refracting telescope at the Lick Observatory, Mount Hamilton, Calif. The construction of this instrument nearly 40 years ago by Ambrose Swasey and Worcester R. Warner, marked a new era in the study of astronomy

as the 36-inch Lick telescope; the 40-inch Yerkes telescope at Williams Bay, Wis., the largest refracting telescope in the world; the 26-inch instrument for the United States Naval Observatory at Washington, D. C.; the 60-inch instrument for the National Observatory of Argentina; the giant 72-inch telescope at Victoria, B. C., the world's second largest reflecting telescope, through the tube of which an automobile could be driven, and the 60-inch Perkins telescope for Ohio Wesleyan University, Delaware, Ohio, which was described in the June issue of POPULAR SCIENCE MONTHLY.

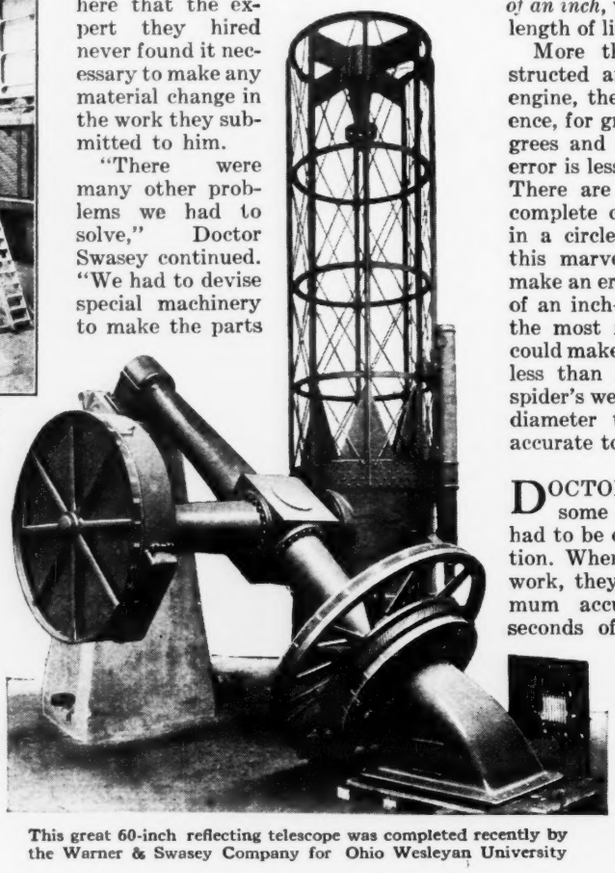
THE story of how Warner and Swasey obtained and executed their first big contract—the construction of the Lick telescope, which revolutionized astronomical research—is a remarkable chronicle of courage and achievement.

When, in 1874, James Lick donated $700,000 to build at Mount Hamilton, Calif., what he specified was to be the largest telescope in the world, Swasey and his partner were not recognized as telescope builders. Indeed they had built only one 9½-inch instrument for their own use; but they submitted preliminary drawings and a bid for the Lick telescope, proposing to produce an instrument with a standard of accuracy and an ease of operation that had been the dream of astronomers. Though they were unknown, and though their bid was the highest received, they were awarded the contract.

"The scientific world was startled when such an enormous task was turned over to so small a firm as ours," Doctor Swasey told me; "and to tell you the truth, no one was more surprised than we. Though we had submitted our bid in good faith and our hopes of obtaining the contract had mounted high, when the actual work confronted us, we were brought almost to the point of confessing that it was too much for us.

"Since neither of us was a university man, we wondered whether we should be capable of carrying on the enormous amount of scientific calculations necessary. At last, though, we decided, 'If we're big enough to land a contract as large as this, we're big enough to carry it out,' and we engaged a noted professor of engineering to check our calculations." It might be remarked here that the expert they hired never found it necessary to make any material change in the work they submitted to him.

"There were many other problems we had to solve," Doctor Swasey continued. "We had to devise special machinery to make the parts of the telescope. The tube, with its accessories, which weighed about 20 tons, had to be mounted on such splendid bearings that it could be swung by hand.



This great 60-inch reflecting telescope was completed recently by the Warner & Swasey Company for Ohio Wesleyan University

"WE WANTED ball bearings, which then were new. Nobody knew how much strain these would stand, which meant they had to be tested. So it was, too, when we decided to use a steel axle instead of an iron one. And after the instrument was completed, there still remained a tremendous problem—that of transporting it up a newly built mountain road along which the wind swept at 60 miles an hour. Even when the instrument was mounted, leading scientists who were present at its dedication in 1888 were skeptical as to its success. But the telescope, largest then in the world, withstood all tests and we were satisfied."

When I called upon Doctor Swasey, I found him going over with one of his engineers a drawing of a mechanism in which he was especially interested.

"I don't care so much for the time it takes!" I heard Doctor Swasey exclaim, as I approached. "Work on it a year, if necessary, to accomplish the result desired."

Doctor Swasey intended his words to be taken literally. While in his relations with his associates he is as sympathetic and kindly as a devoted father, there is one subject on which he is unyielding. That subject is—accuracy.

Possibly I can illustrate just what Ambrose Swasey calls accuracy. A good machinist's micrometer is calibrated to the thousandth part of an inch. Doctor Swasey makes micrometers for astronomical instruments that are accurate to the angular equivalent of a *hundred thousandth of an inch*, which is less than a wave length of light!

More than that, he has constructed and perfected a dividing engine, the most accurate in existence, for graduating circles into degrees and minutes. Its maximum error is less than one second of arc. There are 1,296,000 seconds in a complete circle, which means that in a circle 40 inches in diameter, this marvelous machine does not make an error greater than 1/12,000 of an inch—less than the width of the most microscopic scratch you could make on a polished steel plate; less than half the thickness of a spider's web! In a circle six miles in diameter this machine would be accurate to within an inch!

DOCTOR SWASEY told me of some of the difficulties that had to be overcome in its construction. When, after months of tedious work, they had reduced the maximum accumulated error to 1.5 seconds of an arc, Swasey's engineers felt they had gone about as far as they could, and told him so. But there was another dividing engine in existence that had a maximum error of only 1.2 seconds of an arc.

"I told them I wanted to get the maximum error down to one second, and I said I didn't care if it took a year or two years," Doctor Swasey said. "That is just what they did, and it took a year."

Doctor Swasey's characteristic thoroughness dominates his life so completely that it is manifested even in his recreations. On at least two occasions he has gone all the way around the world without departing from an itinerary arranged before the start.

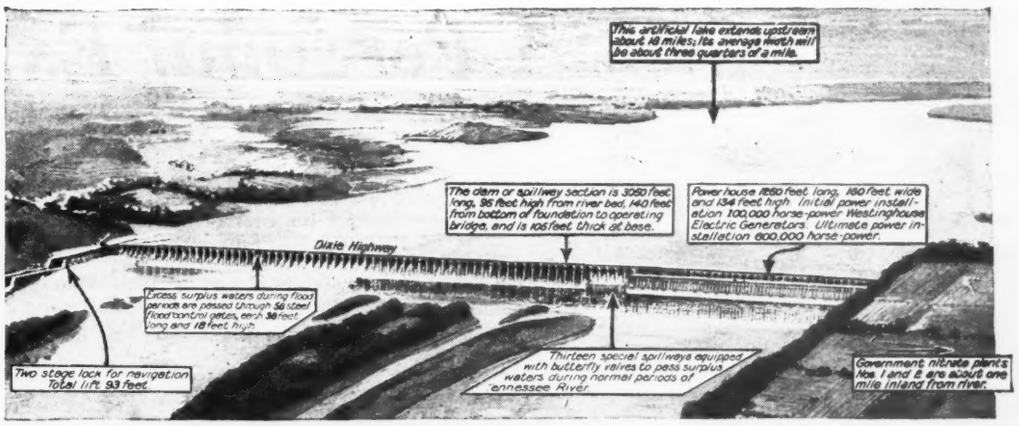
Once on an ocean trip some passengers were arguing about how far away they were from a steamship they saw at a distance. Doctor Swasey took out a pocket rule, sighted the ship across its rim, and a few seconds later announced that the vessel was 3½ miles away. The ship's officers computed the distance with their instruments and found Doctor Swasey was correct. His fellow passengers marveled. But to the man who invented the marvelous range- and position-finders used by the United States Army it was merely a simple calculation.

IN ALL his varied accomplishments and in his mastery of tremendous problems, the creed that has made Doctor Swasey one of the greatest engineers of his time lies in his words to the engineer in his shop:

"Work on it a year, if necessary, to accomplish the result desired."

The World's Greatest Power Dam

By Newton Burke


This artificial lake extends upstream about 10 miles; its average width will be about three quarters of a mile.
The dam or spillway section is 3060 feet long, 95 feet high from river bed, 140 feet from bottom of foundation to operating bridge, and is 105 feet thick at base.
Power house 1150 feet long, 160 feet wide and 134 feet high. Initial power installation 100,000 horse-power Westinghouse Electric Generators. Ultimate power installation 600,000 horse-power.
Dixie Highway
Excess surplus waters during flood periods are passed through 56 steel flood control gates, each 38 feet long and 18 feet high.
Two stage lock for navigation. Total lift 93 feet.
Thirteen special spillways equipped with butterfly valves to pass surplus waters during normal periods of Tennessee River.
Government nitrate plants Nos. 1 and 2 are about one mile inland from river.

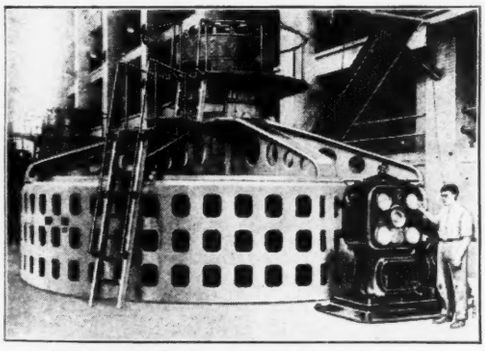
How the Wilson Dam at Muscle Shoals will appear when completed, probably in 1925

SOME time in the next year there will be completed in northwestern Alabama the greatest hydraulic development of the present day and in some respects the most tremendous undertaking of the kind ever prosecuted by man. It is Wilson Dam, which will contribute between 200,000 and 600,000 horsepower in electrical energy to the industrial development of the central part of our Southeast, and will serve as a key in a navigation project that will open up a country rich in mineral, timber, and agricultural resources.

Wilson Dam is part of the Muscle Shoals development, which was begun as a war measure to extract nitrogen from the air for use in the manufacture of explosives. Electrical energy in tremendous amounts was necessary in the process, and Wilson Dam was projected to supply it.

When the war ended, the nitrate plant was virtually completed, and Congress decided also to finish the dam, then scarcely begun, as a source of industrial electricity. Plans likewise were formulated for the construction of two other dams with a view to making navigable the Tennessee River through 85 miles of shoal water and thereby providing a waterway from the Ohio River at Paducah, Ky., to Knoxville, Tenn., a dream of the inhabitants of the country for more than 100 years.

The huge intake to one of the 30,000-horsepower hydraulic turbines of the power plant. It is so large that a motor truck could drive through without difficulty



The type of electric water-wheel generators to be installed at the Wilson Dam development

For the present the Government merely will finish Wilson Dam and a power house—hydroelectric with an auxiliary steam plant—with a maximum capacity of 260,000 horsepower, of which about 200,000 horsepower would be available continuously. Provision has been made, though, eventually to increase the capacity of the power house to 600,000 horsepower, and it is more than likely that the rest of the plans for the Muscle Shoals development will be carried out ultimately.

There are dams in the world that are longer than Wilson Dam, and dams that are higher, but none that is larger in all particulars. It is nearly a mile long and ranges from 95 to 134 feet high. It covers 20 acres of ground. When completed, 36,500,000 cubic feet of masonry will have gone into its construction. The lake created by the mile-long barrier across the Tennessee River extends upstream for about 18 miles. The total cost of construction will be somewhere about $51,000,000.

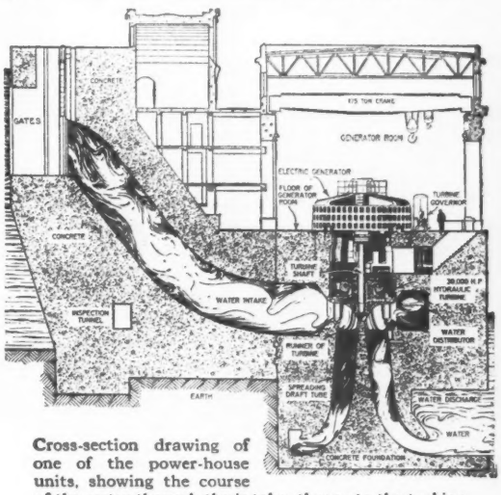
The dam was begun in 1918, and it is expected that it will be delivering power before the end of 1925. Considering the amount of excavation and masonry that its construction entailed, the dam is exceeded in magnitude among achievements in hydraulic engineering only by the Panama Canal.

The flow of the Tennessee River varies greatly. In consequence, the 260,000 horsepower that the power house will be equipped to supply will not be available at all times. At low water, engineers say, the available energy may fall as low as 90,000 horsepower. A supplementary steam generating plant, capable of producing more than 100,000 horsepower, however, will make 200,000 horsepower available the year through. Of this about 50,000 horsepower will be devoted to the production of nitrates. The rest will be for the use of local industries, or it can be employed in furthering the development of superpower through the South.

Muscle Shoals offers four distinct fields of usefulness for times of peace—fertilizer, power, navigation, and explosives. The Muscle Shoals nitrate plants are said to be capable of producing more than 200,000 tons of commercial fertilizer a year. The existing equipment, however, was installed at a time of emergency and without regard to expense, so government experts say it will undoubtedly be necessary to remodel it extensively if nitrates are to be produced cheaply enough to compete with foreign nitrogen compounds.

AS A producer of nitrates for the manufacture of explosives, however, the plant constructed at Muscle Shoals during the war is capable of serving an army of more than 1,000,000 men, and the War Department insists that, even should it be devoted to the manufacture of fertilizer, it must be kept in readiness for munitions manufacture and be instantly available to the Government.

Meanwhile the construction of Wilson Dam proceeds apace, opening to the states of the South new prospects of industrial and commercial development.



Cross-section drawing of one of the power-house units, showing the course of the water through the intake, thence to the turbine and out into the discharge through conical draft tubes that distribute the discharged waters. Gates control the quantity of water admitted. The generator is turned by the 30,000-horsepower hydraulic turbine

How CHLORINE *A Personal Experience*

WHEN Mr. Martin, a member of the Popular Science Monthly staff, came to work with a cold the other day, the Editor sent him to Washington to try the new chlorine gas treatment developed by the Chemical Warfare Service of the U. S. Army, and to make a personal test of its efficacy.

His account of his interesting experiences there, supplemented by facts he obtained from authoritative sources, is a convincing statement of just how much we may expect from this truly remarkable weapon against one of the most common of all human ailments.

Col. M. A. De Laney, Attending Surgeon, U.S.A., who administered the chlorine treatment to President Coolidge

IF YOU ever suffer from colds—and most of us do—undoubtedly you appreciate what a wide difference there is between "catching a cold" and getting rid of one.

In fact, most of us who have tried the various conventional remedies, old and new, without much effect on the cold, probably would testify that there is no way to cure a cold until it has run its course.

Possibly that was true a few months ago, but it's not true now. Colds *can* be cured, and so easily, safely, and quickly that the process seems almost absurdly simple. You enter a small room, you sit there reading or chatting for an hour or so, and, when you come out, your cold is gone!

This is because the Chemical Warfare Service of the United States Army has discovered that chlorine gas, used as a deadly weapon during the late war, can be turned to the service of humanity and employed as a remedy for respiratory diseases.

That chlorine actually cures colds I can testify from personal experience. A few weeks ago, when I entered the little room in the Munitions Building in Washington, D.C., where the medical division of the Chemical Warfare Service is administering this new and amazingly effective treatment to two or three dozen persons a day, I was suffering from a troublesome "summer cold." When I walked out of the little room an hour later, the cold had been knocked out—and it hasn't come back!

Nor was my experience unique. Of about 30 persons whom I saw enter that room, 20 at least assured me they, too, had left their colds behind them, and the others said they had been relieved.

Moreover, two or three thousand persons in Washington and elsewhere can advance similar testimony. President Coolidge has taken the treatment. So have Secretary of War Weeks and Assistant Secretary Davis. Also Rear-Admiral Rousseau. Members of the family of Secretary of State Hughes found relief from colds in the chlorine treatment, as did Mrs. Nicholas Longworth.

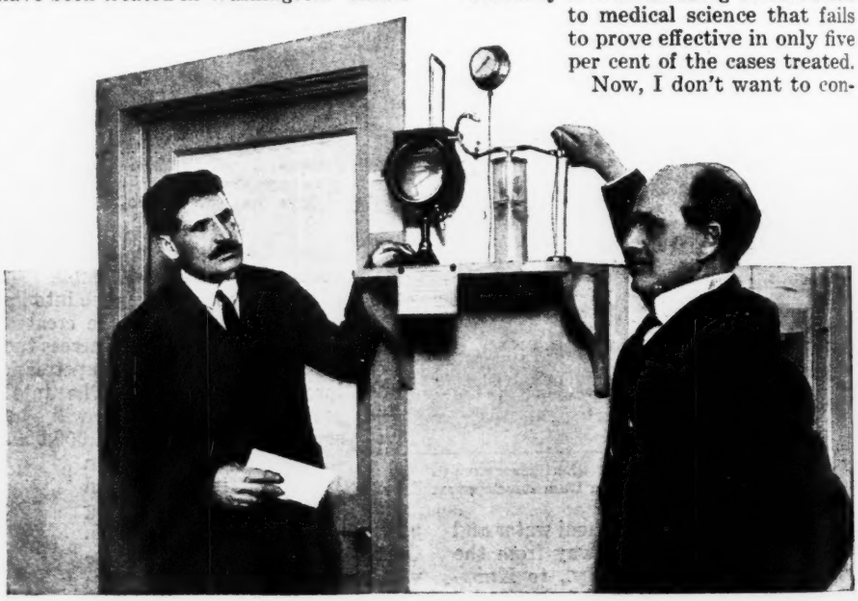
At least 20 United States Senators, 100 members of the House of Representatives, 500 army and navy officers, 1000 employees of government departments and almost as many more private citizens have been treated in Washington. And I have the word of Lieut.-Col. H. L. Gilchrist, chief of the medical division of the Chemical Warfare Service, and of Lieut.-Col. M. A. De Laney, attending surgeon of the United States Army, that not less than 75 per cent asserted without reservation that they had been cured.

With these, of course, must be included hundreds of others who have taken the chlorine treatment at the clinics established in New York, Chicago, and other large cities since the usefulness of chlorine as a medical weapon first was made known.

Official records back up the testimony of persons who have tried the treatment with success. At Edgewood Arsenal, Md., where scientific methods of administering chlorine were developed, 931 persons suffering from various respiratory diseases were treated in the first public test and 665, or 71 per cent, were cured, 547 of them with the first treatment, which lasted an hour. Of the remainder, 218 were relieved, 198 after a single treatment. Only 48 patients, about 5 per cent, failed to show improvement, and almost all of these were suffering from chronic nasal catarrh, which closed their nose passages and prevented the chlorine from entering.

Certainly it is an amazing contribution to medical science that fails to prove effective in only five per cent of the cases treated.

Now, I don't want to convey the impression that chlorine is a cure-all. In fact, its curative powers thus far appear to be limited only to certain respiratory diseases. For common colds, from which at least 42 persons out of every 100 suffer every year, chlorine seems to be virtually a certain cure, especially if the treatment is taken early enough. Similarly, in acute bronchitis, laryngitis, pharyngitis, whooping cough, and influenza, thus far it has cured the majority of cases. In chronic cases of



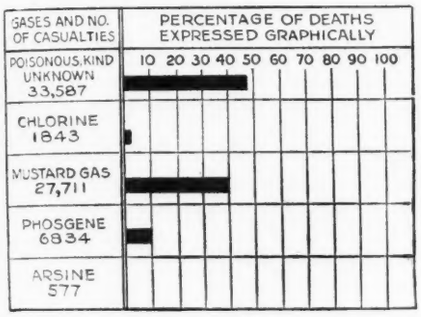
Brigadier-General Ames A. Fries (left), chief of the Chemical Warfare Service, U. S. Army, and Lieut.-Col. H. L. Gilchrist, chief of the Medical Division of the Chemical Warfare Service, with the apparatus used in administering the new chlorine treatment for colds. Colonel Gilchrist is shown operating the valve, which permits liquid chlorine, held in the glass cylinder below, to escape into a salt solution at the left and thence to be siphoned into the adjoining chamber, where sufferers from colds are undergoing treatment

CURED *my* COLD

Story By Robert E. Martin

bronchitis and laryngitis it has proved not quite so effective, though in virtually all cases relief has been felt.

Whether chlorine will prove a cure for the chronic catarrhal affections has not yet been determined, although in many cases it has afforded relief. Also, its efficacy in severe head colds has been doubtful for the reason that swelling of the mucous membranes of the nose prevents the chlorine from obtaining free access to the affected parts. Shrinking the swollen membranes with a drug called "epinephrin," however, has obviated this difficulty somewhat.

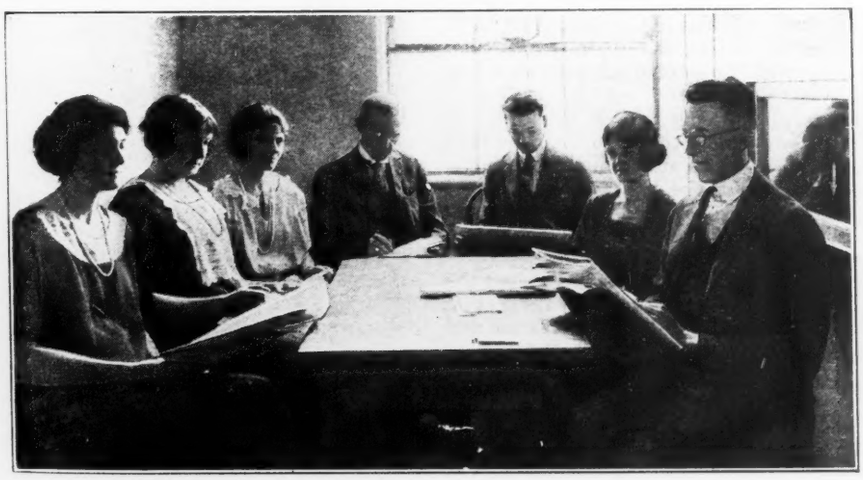

GASES AND NO. OF CASUALTIES
PERCENTAGE OF DEATHS EXPRESSED GRAPHICALLY
10 20 30 40 50 60 70 80 90 100
POISONOUS KIND UNKNOWN 33,587
CHLORINE 1843
MUSTARD GAS 27,711
PHOSGENE 6834
ARSINE 577

This chart shows graphically the small percentage of chlorine gas casualties among American soldiers during the war as compared with those resulting from other poison gases. In the chlorine treatment for colds absolute safety to the patient is assured because the gas is used in low concentration

In asthma and hay fever, the chlorine treatment, according to officers of the Chemical Warfare Service, appears to be useless; in some cases, in fact, it is likely to have an irritating effect on the membranes of the nose and throat. Also, chlorine will not cure tonsillitis, tuberculosis, or pneumonia. The reason is clear. The fundamental principle upon which the treatment depends is that certain bacteria which lodge on the surface of the mucous membranes, causing colds and other common respiratory diseases, die very quickly under the action of chlorine. Obviously, if the bacteria are not present, as in asthma and hay fever, chlorine cannot effect a cure. Neither can it penetrate the tissues to attack deep-seated bacteria, as in tuberculosis, nor can it reduce the pus-filled tonsils of tonsillitis.

THE chlorine treatment is simple. You simply remain in one small room for an hour. In the case of the government clinics at Washington, the tediousness has been relieved by providing books, magazines, and newspapers. Also the development of a portable apparatus by means of which chlorine can be administered to a single patient permits a sufferer to rest comfortably in his own home or office while undergoing treatment. Despite the fact that chlorine was used as a war weapon, there is no reason why the most nervous person should fear to take the treatment. It would require about 100 times the strength of chlorine that is used in the treatment before there would be danger in breathing the gas.

When the patients are seated, a valve is opened, and a small amount is fed from a glass cylinder containing chlorine in liquid form. An ordinary electric fan beside the inlet pipe circulates it through the room. When the treatment ends, all the chlorine-bearing air is driven out by fans.



Interior of the chlorine chamber of the Medical Division, Chemical Warfare Service, Washington, D. C. Persons taking the treatment merely sit in the chamber for an hour, reading, chatting or otherwise amusing themselves, and in the vast majority of cases when they come out of the room they are cured. At the extreme right is a window through which the physicians administering the treatment may observe the patients. Enough chlorine for a single treatment of seven persons simultaneously costs only about six cents

THE apparatus consists of a small glass cylinder, capable of holding a little more than a quart of liquid chlorine. When a valve at the top is opened, chlorine escapes through rubber tubing to a glass cylinder filled with a salt solution. Thence a simple siphon causes the chlorine to pass in jets into the room through glass piping.

President Coolidge, whose severe cold recently was relieved by chlorine gas

A single treatment—enough for seven persons simultaneously—costs about six cents.

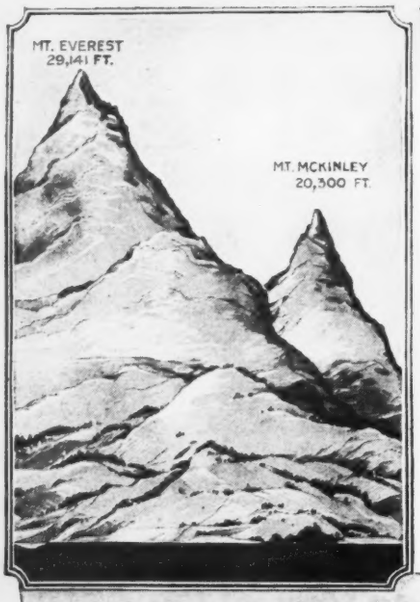
"One need not make extravagant claims for the chlorine treatment," Colonel Gilchrist, chief of the medical division of the Chemical Warfare Service, told me. "The plain truth about it is surprising enough. It would scarcely be too much to say that there is no excuse now for a person to have a cold. A single hour in the chlorine chamber at a time when the cold is first felt coming on will cure it—absolutely. In the matter of common colds the treatment has proved itself beyond question.

"I MIGHT say also, that now we have the chlorine treatment, there never should be another influenza epidemic.

"The records of the Chemical Warfare Service seem to indicate that chlorine, despite the terrible reputation it acquired during the war, is by no means as dangerous as is popularly believed. The total number of American soldiers who were victims of chlorine gas during the war was 1843, and of these only *seven* died. So if chlorine proved no more dangerous than that when hurled at soldiers with deadly intent, no one should fear it when it is employed as a medical agent and administered by a competent physician by means of scientific apparatus that keeps it always under control."

Don't, though—and this warning comes from several officers of the Chemical Warfare Service with whom I talked—don't try to treat yourself with chlorine!

But if you feel a cold coming on, and there's a chlorine clinic available, don't hesitate to visit it. The writer can testify that the gas does its work.



Wonderlands Where

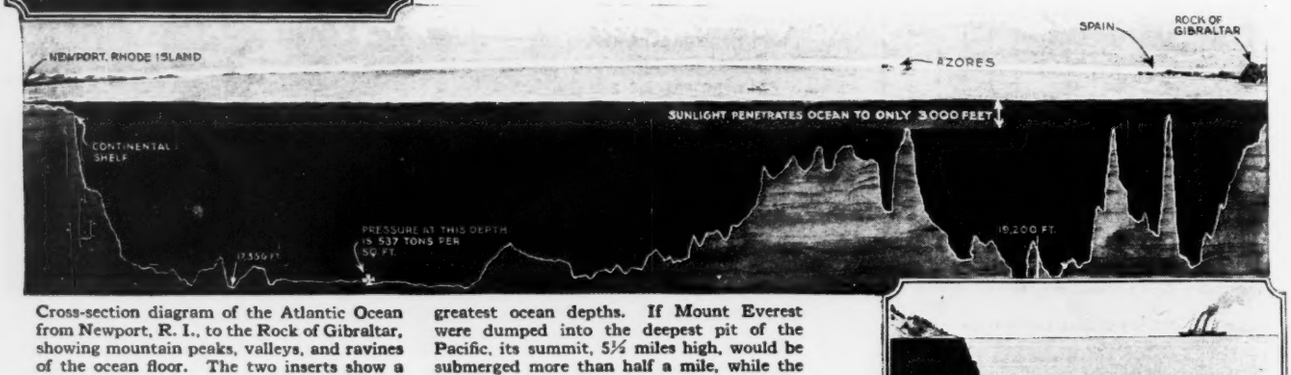
What Science Knows about

and awed by their majestic height. Yet the average depth of the sea is more than five times greater than the average height of land above sea level over the whole earth. Including our greatest mountains, the mean rise of the land above the sea is less than half a mile. The depth of the sea averages 2½ miles. Moreover, more than half of the sea is between 2½ and almost four miles in depth, and here and there in its basin are great caverns called "deeps" into which Mount Everest, tallest mountain on earth, might be pitched and swallowed up. In fact, if Mount Everest were dropped into one of these great ocean pits, its summit, 5½ miles high, would be submerged more than half a mile.

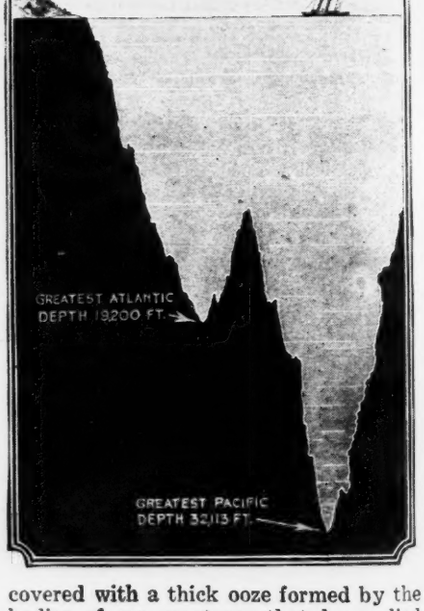
More surprising still, if some sort of giant scoop were to level off all the land flush with the sea and dump all the debris into the water, the end of the task would find the sea scarcely changed at all. There would still be an ocean a mile and three-quarters deep!

No man, of course, ever has visited the depths of the sea, and science says that no man ever will, because no submarine and no diving apparatus could be devised that would not be crushed by the tremendous pressure of the water at even the lesser ocean depths. Through the instruments of one of the newest sciences—oceanography—however, man has carried on considerable exploration beneath the surface of the huge mass of water that composes so large a part of the earth's surface.

THOUSANDS and thousands of soundings have revealed facts that have enabled scientists to present a nearly exact picture of the ocean basin, which they have found to be a great level plain,



Cross-section diagram of the Atlantic Ocean from Newport, R. I., to the Rock of Gibraltar, showing mountain peaks, valleys, and ravines of the ocean floor. The two inserts show a striking comparison between the heights of two of the world's tallest mountains and the greatest ocean depths. If Mount Everest were dumped into the deepest pit of the Pacific, its summit, 5½ miles high, would be submerged more than half a mile, while the greatest Atlantic depth would swallow all but a small portion of Mount McKinley



By Raymond J. Brown

PICTURE a place of inky darkness and intense cold, a region to which the rays of the sun never have penetrated; a barren waste seemingly unending, bereft of vegetation and air, with oozy slopes inhabited by queer, crawling creatures; a place where no man could exist for an instant, where no work of man could be placed without being crushed to shapeless uselessness under a weight greater than all the mountains of the earth.

Most of our globe is like that, for that is the bottom of the sea, as pictured by modern science.

Of course, this represents the sea in its most fearsome aspect. There is a much more pleasant side to the sea; many of them, in fact. In the myriads of forms of animal life that inhabit its depths, in its abundant vegetation, in the sublime dignity and grandeur of its wide expanses, the sea is fascinating, beautiful, and inspiring. Let us observe both sides of the picture.

NO DOUBT you remember from your schooldays that a little less than three-quarters of the earth is covered by water. In round numbers, the earth's surface consists of 57,000,000 square miles of land, and 140,000,000 square miles of water. Those figures, however, give but a vague idea of the real immensity of the vast, mysterious sea.

Any one who has seen any of the great mountains of the earth has been thrilled

Government to Plumb Depths of Sea

PLANS for the most complete survey of the ocean from top to bottom ever attempted recently were inaugurated by scientific branches of the government and allied institutions, under auspices of the Hydrographic Office of the U. S. Navy. Instead of a globe-girdling expedition, a comparatively small section of the sea will be selected for intensive study. The Aleutian Islands region of the Bering Sea and the Caribbean Sea are now under consideration as offering the best opportunities for scientific investigation. Ships will be fitted out with complete laboratories and equipped with the most modern scientific apparatus for the first cruise.

covered with a thick ooze formed by the bodies of sea creatures that have died since the ocean first was formed. Gravel, sand, mud, volcanic dust, meteoric iron, bits of land rocks, and precipitations from sea water also lie on the ocean floor.

THE deeps are not gradually sloping valleys, but long, narrow fissures, believed to have been caused by earthquakes, since they are found in places where submarine earthquakes are frequent. There are also numerous mountains—quite as many relatively as on land. When these mountains are very high, their summits project above the surface and we call them islands.

One of the most remarkable geological

the Sun Never Shines

the Majestic Depths of the Sea

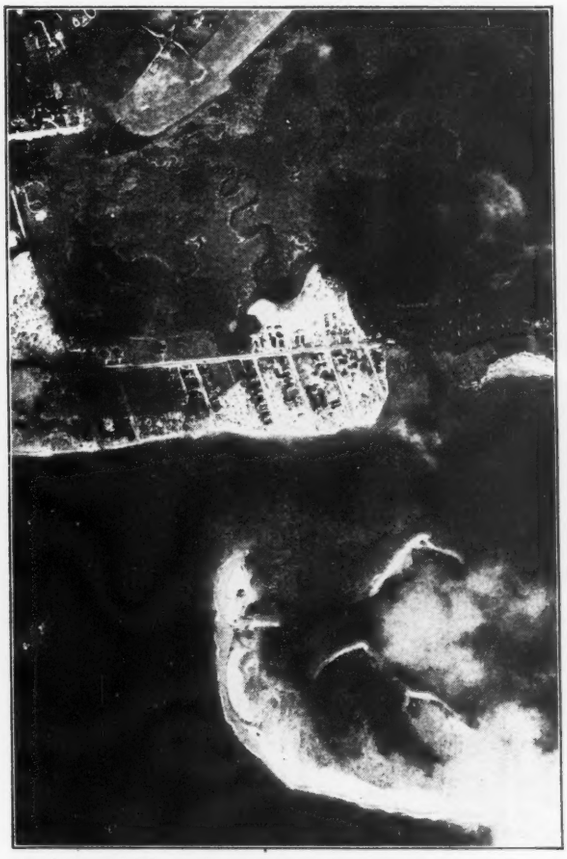
The queer seahorse (*Hippocampus*) that inhabits the warmer parts of the sea. It swims in an erect position and strikingly resembles the knight of the chess game

formations of the ocean basin is what is known as Telegraph Plateau, a great ridge that extends in almost continuous line from Newfoundland to the British Isles. The discovery of this ocean eminence was of great importance in aiding the establishment of transatlantic cable communication; from which fact it derives its name.

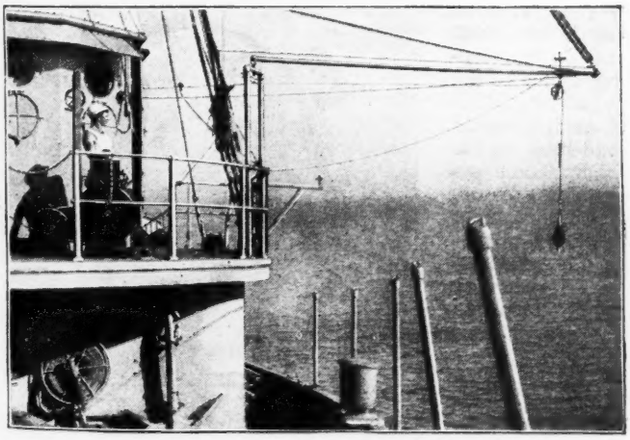
YOU know, of course, that most of the sea is a beautiful transparent blue. Just why this is so, science cannot say. The reflection of the color of the sky probably has something to do with it. Likewise the varying depths; for the deepest blue is found far from land, while shallow waters, especially in the tropics, are always green. The Arctic Ocean, too, is green. Submarine vegetation here and there affects the color of the sea. Thus the Red Sea gets its color and its name from the reddish algae, or seaweed, that float near its surface. Elsewhere soil and mineral deposits from the land tint the waters near the shores.

Also, the purity of the water has some bearing on its color. A tank of the purest distilled water is blue, and virtually matches in color a specimen of water taken from the sea. However, the sea is transparent and translucent only near its surface. Below 500 fathoms (3000 feet) the light of the sun does not penetrate. Hence, all the vegetation of the sea is above that level, for plant life requires the light of the sun to reduce the carbonic acid needed for its existence.

Below 250 fathoms, or about 1500 feet, the heat rays of the sun cannot penetrate, and their effect is weakened considerably



A remarkable airplane photograph of the waters of East Rockaway Inlet, L. I., taken from a height of 10,000 feet, and revealing in the ocean a deep channel in the foreground, submerged sand bars, and a meandering stream on land



Measuring ocean depths with the latest form of electric deep-sea sounding machine from one of the vessels of the U. S. Coast and Geodetic Survey. The greatest known depth near the coast of Mindanao, Philippine Islands, was measured in this way

above that depth. The result is that there is a thin layer of warmish water on top of the sea, below which the water is cold. At 50 fathoms science has found that the temperature of the water varies little more than a degree a year. At 100 fathoms there is no change in temperature at all. All the water under 500 fathoms, which means about 90 per cent of the ocean, is colder than 40 degrees, while at the bottom the temperature is 32 degrees, or less—just above the freezing point for salt water, which is 28½ degrees.

All of the sea is salt, though some parts are more salty than others. The degree of salinity depends to a great extent on the climate. Where the heat of the sun causes much evaporation—as in the Red Sea—a large percentage of salt is in the water. Where the evaporation is less, the percentage of salt is correspondingly less. Throughout the whole ocean there are about 35 pounds of salt to each 1000 pounds of sea water, about 5,000,000 cubic miles in all, or more than enough to bury the United States a mile and a half deep. We speak generally of the "salt" of the ocean; actually we should say "salts," for in addition to sodium chloride—the salt we use with our food—the sea contains the salts of many other metals. In fact, the sea is a veritable treasure house. There is more gold there, for example, than ever has been mined from the land—about a grain to every ton of water. Silver is there, too, though only in about one-fifth that quantity.

Thirty-two of the 92 elements known to exist have been found in sea water. Scientists believe that most of the others are there, and await merely the development of new methods of chemical analysis to bring them to light. These chemicals have been washed into the sea from the rocks of the land. Every year 500,000,000 tons of salts are carried to the sea by the American rivers alone.

The water of the ocean is in constant circulation; it has its rivers, its lakes, its seas. These are due to the action of the sun, which brings changes in temperature, in wind, and in the density of the water.

THE Gulf Stream probably is the best known example of an ocean river. Starting at the Gulf of Mexico, this warm flow of tropical water skirts the American coast to the banks of Newfoundland, where it takes its course across the Atlantic and divides into two streams, one flowing east toward the Azores, the other passing the shores of the British Isles and Norway and disappearing into the Arctic Ocean.

The waters of the Gulf Stream are blue, often in marked contrast with the greenish seas through which it passes. It exerts a profound influence on the climate on many parts of the world. Thus, it carries a comparatively mild climate to Scotland, while Labrador, in the same latitude at the other side of the world, is a place of ice and cold. Similarly, Portugal, whose coast it washes, is extremely temperate, while a corresponding part of

(*Continued on page 128*)

How My Speed Rocket Can Propel Itself in a Vacuum

By Prof. Robert H. Goddard

Head of the Department of Physics, Clark University

THE plan of Professor Goddard to shoot a small model of a high speed moon rocket within the next few weeks, as described in the April issue of POPULAR SCIENCE MONTHLY, called forth this question from many of our readers:

"How is it possible, as Professor Goddard proposes, for the rocket to propel itself by successive charges exploding in space? Since the space beyond the earth's atmosphere is practically a vacuum, what is there for the explosions, or expelled gases, to push against?"

We put this question to Professor Goddard himself, and he willingly prepared for our readers the following scientific explanation of how he believes his rocket will be able to propel itself in a vacuum.—THE EDITOR.

IN DISCUSSING the high-altitude rocket, there is not much question as to the long ranges possible, if a high velocity of the expelled gases is had with a rocket consisting chiefly of propellant material. There is, however, much criticism of the idea of the rocket propelling itself at a height where there is practically a perfect vacuum, it being maintained that there will be "nothing for the explosions, or expelled gases, to push against."

Contrary to common supposition, however, the explosions have a greater effect in a vacuum than in the air. In fact, if the air were very much compressed, the explosions, instead of giving strong propulsion, would have no effect whatever.

To see this, it must be realized that what pushes the rocket forward is the *gas that is shot back toward the rear*. Thus if a boy on roller skates throws some weights backward, he will be pushed forward by the reaction, as shown in Fig. 1. The faster he throws the weights, the faster he will be pushed forward. In a vacuum, the gases from the rocket will escape at a high speed, and the rocket therefore will continue to be kicked forward by the reaction.

Fig. 1

EVERY one knows that a blank cartridge, fired in a revolver, produces a kick of the revolver; and the apparatus shown in Fig. 2, in which a blank cartridge is fired in a revolver free to turn about an axis, shows that the kick occurs also in a vacuum.

Fig. 3

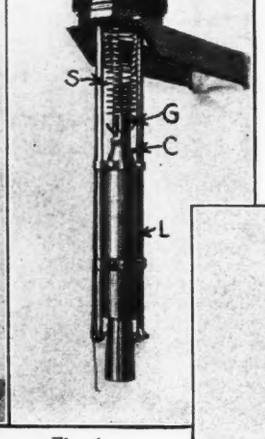


Fig. 4

Fig. 2

On the other hand, if a blank cartridge could be fired in a tank containing air under a pressure so great that no gas could escape, then there would be no motion of escaping gases to give a kick to the revolver.

Ask any engineer if he would discard the condenser on his engine, in which steam exhausts into a partial vacuum, and replace it by a tank under pressure. He will tell you that if there were sufficient pressure in the tank into which the exhaust passes, it would stop the engine. The same principle applies to the rocket.

IN ORDER to test this point, a rocket chamber was fired in a tank pumped down to but 1/1500 normal atmospheric pressure. The chamber *C*, shown taken apart in Fig. 3, was weighed down by lead jackets *L*, and hung by a spiral spring *S*, as in Fig. 4. When the gases were fired downward, the recoil kicked the chamber upward, and the rise was registered by a scratch on a strip of smoked glass, *G*. The apparatus shown in Fig. 5 has been widely illustrated under various titles, but it simply is the device used in measuring the reaction in a vacuum.

The gases were prevented from rebounding by being shot downward into a tubular tank, Fig. 5, in which they circled around and around, being gradually slowed down by friction, with no possibility of their rebounding. Another, larger tank also was used, in which the gas was shot downward into a coil of wire fencing, which prevented rebound of the gas.

THE results of 50 tests proved that there is *20 per cent greater lifting force* of a rocket in a vacuum than in air at ordinary pressure. This proof of reaction in a vacuum is but one of a number of matters that have been settled experimentally, and that will lead to rather startling results.

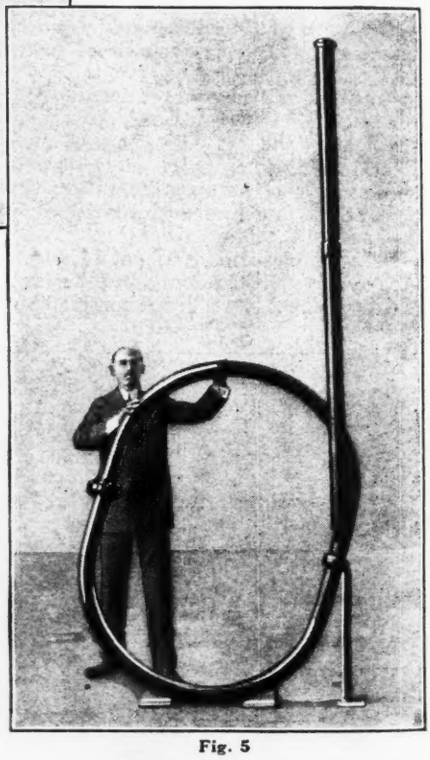


Fig. 5

Can you imagine two vast flaming balls—one of them 8,000,000 times our earth in volume—hurtling about each other in a 173,000,000-mile path every two weeks! Read about this wonder of the skies in next month's issue.

Swindlers Who Rely on Science

Mechanical Tricks of the Carnival Bunco Man

As told to
Walter B. Gibson
by a Retired Showman

PROBABLY you know the traveling carnival. A tented city of colored canvas booths, blatant music, bawling voices, and jostling crowds. Calliopes and mechanical bands blaring out their noisy tunes. Flaring lights illuminating the stands of refreshment venders, and a myriad of sideshows. Everywhere noise, hurry, and confusion.

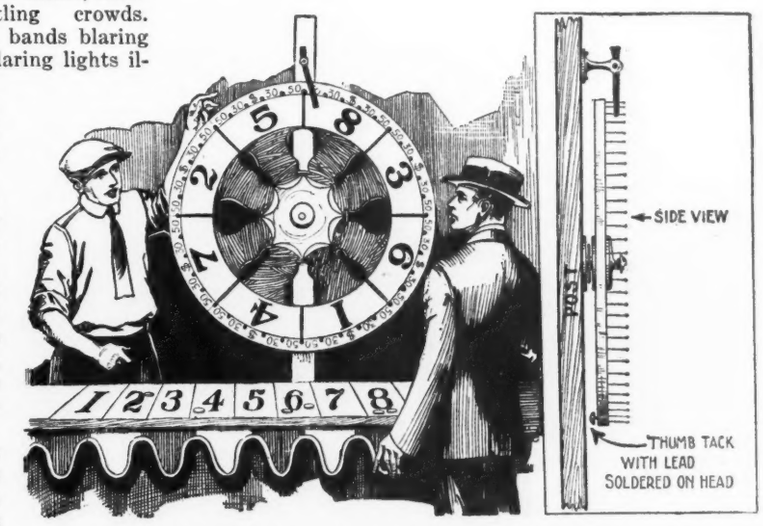
Probably, when a carnival has come to your town, you've bought numbers on a prize wheel, thrown baseballs at canvas-covered cats, or rolled little wooden balls down tiny bowling alleys, trying to win one of the many flashy prizes so enticingly displayed.

Has it ever occurred to you how seldom you have won, or how seldom you ever have seen any one else win?

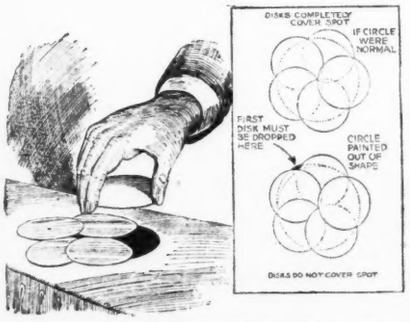
The explanation is simple. While there are plenty of honest men and games in the traveling shows, many of the games of "chance and skill" that are prominent features of every carnival can be made cunning swindles by misuse of the principles of science.

Now, a dishonest carnival gamester, or "grifter," as he calls himself, probably doesn't fit in with your notions of a scientist, and yet he is just that, for it is by employing the laws of physics and mechanics that he fixes his games to remove your chance of winning. He's a psychologist, too. He understands the workings of your mind and uses that knowledge to coax the money out of your pockets.

The games of the grifter fall into two general classifications—games of chance, in which you trust entirely to luck to win a prize, and games of "science and skill," in which your chance of winning presumably depends on your own ability. The games of chance usually are operated fairly, for here the well-known mathematical principle, the law of averages, makes the grifter a winner. When you win a prize on a paddle wheel, for example, there are always enough non-winners to pay for the prize and give the operator a profit to boot. Yet even in such a game the grifter employs his tricks to increase his earnings.



The operator of a crooked percentage wheel says he'll pay you 10 to 1 if the wheel stops at a number corresponding to the number on which you place your money. To make a clean-up he deftly pushes a leaded thumb-tack into the back of the wheel opposite a number that is not being played. How he takes advantage of the law of gravity to take your money is shown in the side-view diagram


DISKS COMPLETELY COVER SPOT
IF CIRCLE WERE NORMAL
FIRST DISK MUST BE DROPPED HERE
CIRCLE PAINTED OUT OF SHAPE
DISKS DO NOT COVER SPOT

The "red spot game" is found at almost any carnival. All you have to do to win a prize is to drop five metal disks so they will cover a painted circle. But unless you discover a trick bulge in the circle and cover that bulge first, some portion of the circle always will remain exposed. A crooked operator knows where the bulge is by the aid of a very fine mark that a player would not notice

THE percentage wheel is one of these devices that may be "gaffed" or controlled by taking advantage of the law of gravity. It resembles a paddle wheel, but is divided into eight large sections, each of which has five subdivisions. Correspondingly numbered sections are painted on the counter. The player places a coin on the "lay-down." If the wheel stops at the number he is playing, he is paid 10 to 1, and if his coin is on the center subdivision, 3 to 1. With the playing price a dime and eight persons are playing, five spins of the wheel pay the operator four dollars, from which, by the law of averages, his profit will be about two dollars and sixty cents.

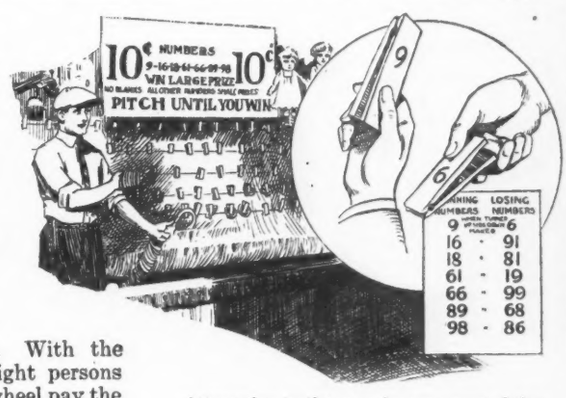
But if all the places are not taken and the grifter wants to clean up, he deftly places a thumb-tack, weighted with a drop of lead, on the rear of the wheel opposite a number that is not being played. The weight of the tack causes the wheel to stop at the "open" number; consequently, the operator does not have to "pay off," and the "play" is all profit.

Some towns bar games of chance, but allow games of so-called "science and skill." One of the most popular games of this type is the knife rack, where rows of attractive looking deerfoot knives line the booth. When you pause at his stand, the operator shows you how easy it is to drop a little wooden ring over the handle in order to take away the knife as a prize. He sells you six rings for a dime.

Even if you buy a hundred rings, you never will win. It is absolutely impossible to toss a ring over one of the knife handles from the angle at which you must throw, for the handles have slanting ends, and the knives are turned so that you are throwing the rings at the flat end of the handle that faces you, and not at the point.

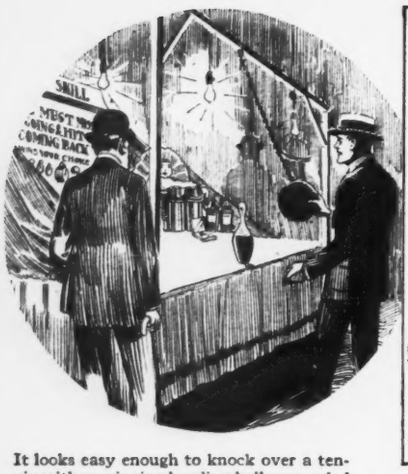
THE grifter is a keen practical psychologist. He knows that you come to a carnival to have a good time, and that you are willing to pay for it.

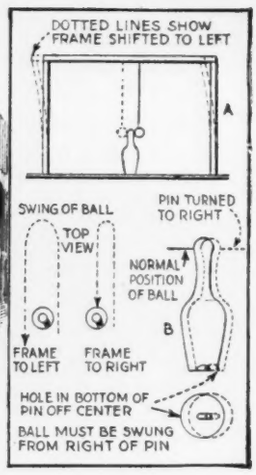
Take the "three-pin game." All you have to do to win at this is to roll a little ball down a miniature bowling alley and knock over three tenpins. If you do it, you get a dollar bill. But you never knock down more than two, because the two front pins are so set that the ball passes between them without striking both at the same time. If you get discouraged but look prosperous, the operator displays more of his "art," using a confederate known as a "capper" or a "shill" to lure you on. The confederate can make a perfect shot every time, because the operator has set the pins closer together for him.



Attempting to throw a ring over one of the winning pins on a crooked clothesline game is hopeless. If you win you lose; for the gamester has selected winning numbers that he can transform into losers by the simple process of turning the p n upside down

The swing ball game is a notorious goldmine for the grifter. Here a ten-pin





It looks easy enough to knock over a ten-pin with a swinging bowling ball suspended from a frame above. The game is simply to swing the ball to the right of the pin so that it will strike the pin coming back. But if a grifter is operating the game dishonestly, either he shifts the unsteady frame, throwing the ball off its course, as in A, in the diagram above at right, or he places the pin off center, out of the line of swing, as indicated in B

stands on a counter lined with the inevitable flashy prizes. Beside the pin hangs a bowling ball suspended from a frame above. The game is to swing the ball to the right of the pin so that it will knock the pin over on its return swing. Purposely faulty construction renders the frame wabbly, so that the operator has only to lean against it to throw the ball from its course. The pin also is made lopsided and off center to set the game against you.

To knock a large canvas tom cat from a rack only a few feet away with a ball seems like an easy way to win a prize—but try to do it! The cat leaves the rack only when the shill tries his luck. In this case the gamester uses a little physics to cheat you. Inside of the cat is a movable weight. Pushing this to the bottom practically anchors the cat to the shelf by lowering its center of gravity to its base. When the shill throws, the weight is shifted to the center by tipping the cat upside down. This raises the center of gravity so that the ball may easily knock the cat to the ground.

Another "game of skill" is called "Pigs in Clover." You tip a board to roll half a dozen balls through spikes into numbered pockets at the other end. Low scores give small prizes, high scores "grand" prizes. These games are controlled by setting one or two spikes in front of important holes, or else high or low numbers are lacking so that only moderate scores can be made.

Don't think, however, that the career of the dishonest gamester is a bed of roses lined with greenbacks. Quite the opposite. Frequently he is compelled to pay big money to grafting officials before they will permit him to run his game, or he may be forced to pay very high rentals for his booth space.

To avoid these hazards a class known as "small-time grifters" has sprung up. Their games are comparatively primitive. One of these games is known as the string game. The operator holds a hand full of loose string ends, which pass over a rack and are attached to a shelf full of prizes. All you are asked to do is to pick a string and take the prize attached to it; yet you never get anything but a worthless trinket, because the cords attached to the better prizes are doubled back in the grifter's hand out of sight and reach.

The grifter's ingenuity is shown by the way he "rigs" various forms of "strikers" that appear to be genuine strength-testing machines.

The "high striker" on which the player swings a wooden mallet to drive a lead weight up a long wire track to strike a gong, likewise is subject to control by the operator. After ringing the bell once or twice, players always seem to lose strength. The track on which the lead weight travels is connected with one of the guy wires. When you start, the grifter leans against this trick wire, tightening the track and allowing you to score. When he takes his weight from the guy wire the track becomes slack and the weight bumps against the post. When the wire is slack, Samson himself could pound all day and never hit the bell.

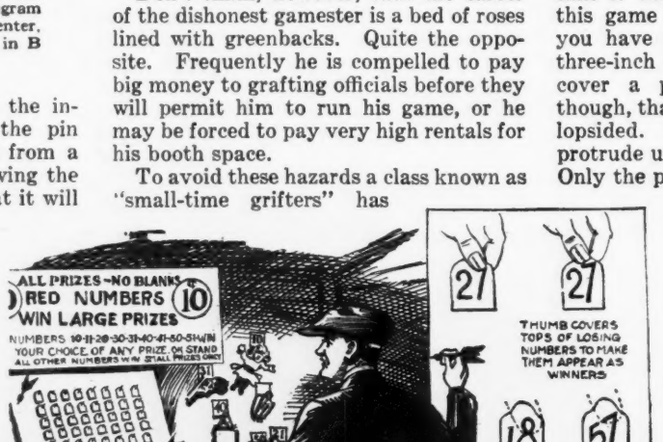
NO GAME is too large or too small to be controlled—not even the small "roll-down" or "haphazard" games that consist of glass boxes into which marbles or coins are dropped to roll toward a row of pockets protected by protruding nails. These games are "fixed" by a movable row of concealed nails, which may be shifted to open or close the winning numbers.

One of the games that call for a little skill is the red-spot game. You'll find this game at almost any carnival. All you have to do to win is to drop five three-inch metal disks so that they will cover a painted circle. It happens, though, that the so-called circle is slightly lopsided. Some portion of it always will protrude unless this bulge is first covered. Only the proprietor of the game can pick this out with the aid of a very fine mark that players never notice. They fall for it because it looks so easy.

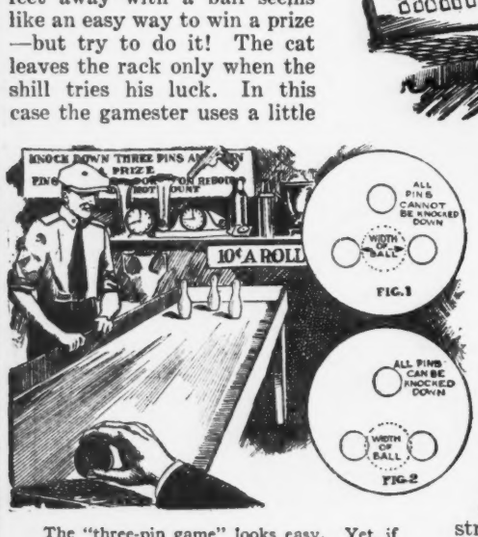
Yet I would not have you believe that all games such as are mentioned in this article are dishonestly operated. In a large number of them the house is content to let the mathematical law of averages take its course. It is with the tricks of the swindler that I have been dealing.

Phineas T. Barnum, who was the greatest of all showmen, summed up the lure of the carnival games in one immortal sentence, "There is one born every minute."

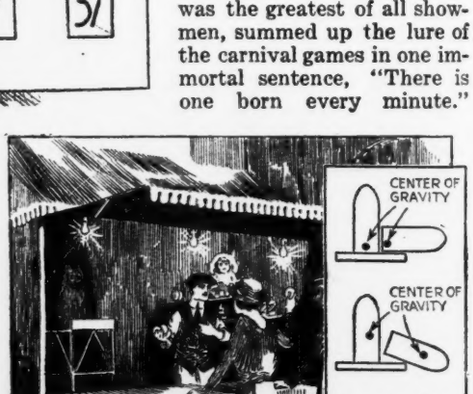
Don't join that number by rushing blindly into the grifter's hands. Patronize the rides and legitimate booths that you know are genuine and the gambling parasite will quickly fade away.



When business is slow and the gamester's confederate appears to lure you on by winning a prize, a simple expedient to make him win is to cover the tops of losing numbers with the thumb, thus making them appear as winning numbers



The "three-pin game" looks easy. Yet, if a grifter wishes, it is impossible to knock over all three pins, because the two front pins are farther apart than the width of the ball, as in Fig. 1. The grifter's confederate, however, finds it easy. For him the pins are set closer together, as shown, in Fig. 2

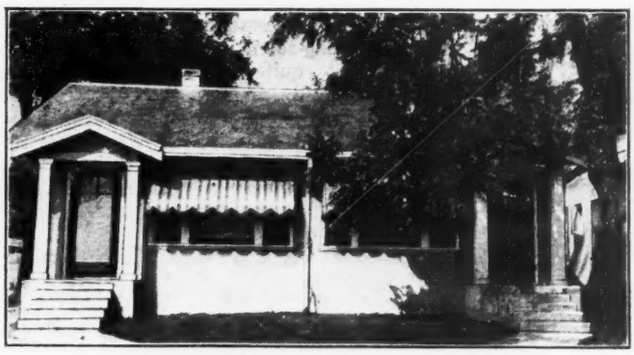


When you try to knock the canvas cat from the rack with a thrown ball, the dishonest gamester has you at his mercy. In some such games, inside the cat is a movable weight. Shifting the weight to the bottom practically anchors the cat to the rack by lowering its center of gravity

A Five-Room Home in Three Rooms

How We Designed a Duplex Bungalow that Pays for Itself

By
A. May Holaday



Front view of the attractive duplex bungalow ingeniously designed by the writer. The detailed floor plan and side elevation are shown at the right

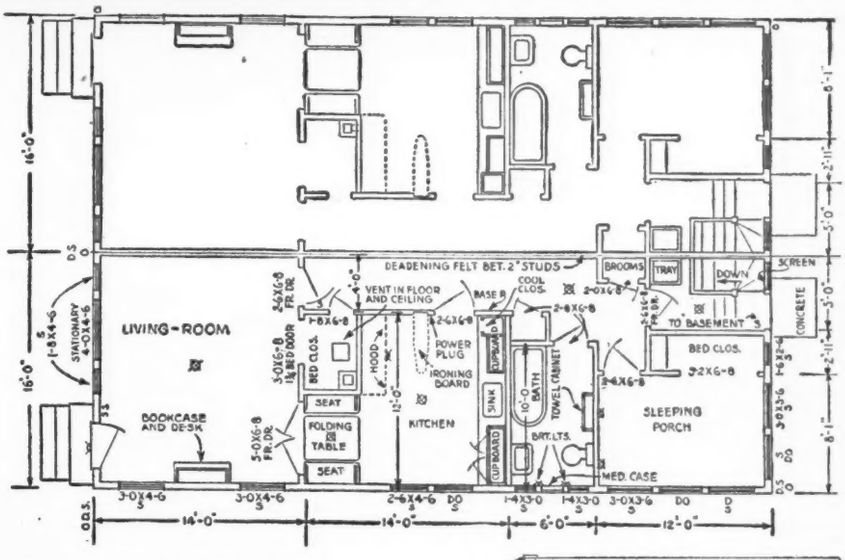
A YEAR or so ago, John and I, like many another couple, were finding the housing problem about the most difficult one with which we had to wrestle. We were tucked away in three rooms and bath in a large apartment house. The rent was high, and other inconveniences—particularly the lack of room, freedom, and comforts—from which John suffered, made the conditions under which we lived decidedly unpleasant.

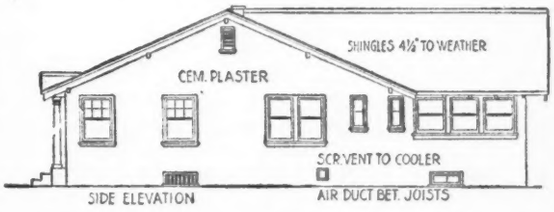
Now, though, so far as we are concerned, the housing problem has ceased to exist. We are living virtually rent free in a real home with every comfort and convenience we could wish for. There is less work for me; John has all the room and freedom he desires. Months have passed since last I heard what used to be his nightly plea in the apartment: "Come on, let's go some place—any place!"

WHAT we have done any other couple can do also. The way in which we solved the housing problem was almost absurdly simple. We built a duplex bungalow. People who live in California will know what I mean. But for those who live elsewhere I'd better explain that a duplex bungalow is a one-story building divided into two apartments, each consisting of three rooms and bath. There are separate entrances, and the two families occupying the apartments need meet no more often than their social inclinations direct. Usually the builders of the "duplex" occupy one apartment, and the rent they receive from the other pays the expenses of the whole house—interest on mortgage, taxes—everything.

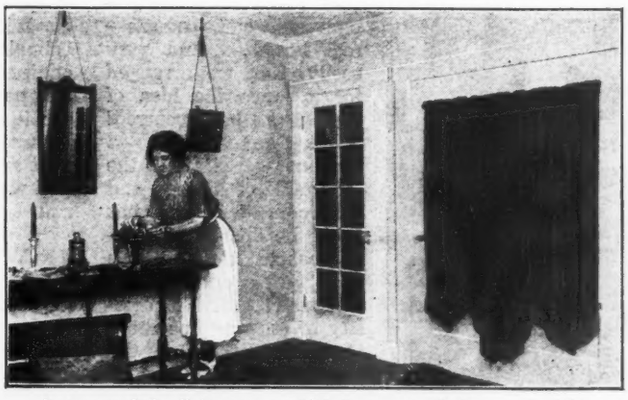
Now, fellow Californians and other people who have heard of the duplex plan are going to say right here that what John and I did was nothing unusual. They're going to wonder what possible excuse I can give for writing an article about our duplex, inasmuch as many thousands of them had been built and were occupied while John and I were still paying rent for an apartment. We didn't invent the duplex, they'll say; hence, what right have I to herald what we did as an extraordinary achievement?

True, we didn't invent the duplex; but we did design a duplex—the one we are living in—that is unlike any other in the world. It took a lot of pondering and pencil-chewing to do it, but we succeeded in obtaining all the comforts of a five-room apartment in three rooms.





We utilized every square inch of floor space and wall space. We achieved not only the appearance of roominess, but roominess itself. Actually we have only three rooms; still, John and I never are in each other's way—we have even a spare bedroom when we are entertaining a guest! stalling wall beds that fold back in the daytime, in the living-room and dining-room. To get from the living-room, say, to the kitchen, you must pass through the dining-room, for doors opening from one room to the next offer the only way of walking from front to back.



A corner of the living-room, which becomes a bedroom at night. The door to the bed closet, at the right, is made attractive by a silk drape. The door leads to a service hall, giving access to other rooms

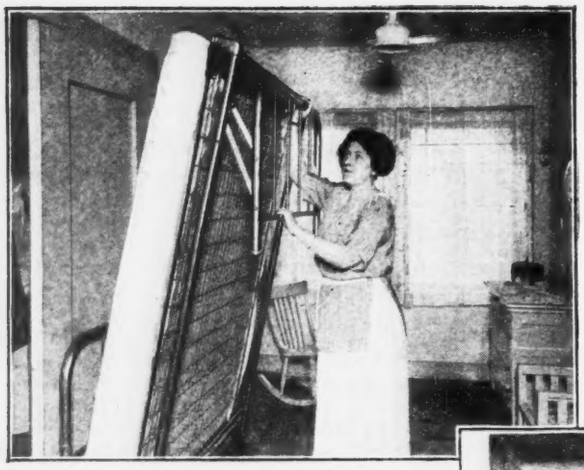
It was I who first suggested the duplex as *our* solution of the housing problem, and when I persuaded John to go with me and look at some, he discovered more objectionable features in them than he'd found even in our apartment.

A DUPLEX, of course, occupies only one lot. Therefore, the only feasible arrangement of rooms is one behind the other, the same scheme used in the old-time "railroad" flats. A living-room in front, then a dining-room, then a kitchen, and a bath in the rear is the conventional plan. "Bedrooms" are provided by in-

After we'd inspected a few, John informed me that so far as he was concerned, a duplex was not for us.

"I'd just as lief live in a tent!" were his exact words. "I'm used to sleeping in a bedroom, and I'm not going to sleep in a dining-room for anybody! Another thing—a bathroom ought to be convenient. I don't intend walking through two or three rooms to shave! We'd better stay where we are. After looking at these things, I find the little old apartment isn't so bad after all."

To tell the truth, I was a



The airy bedroom is transformed into a sun-room or sewing-room by folding the bed into a closet. One quick movement raises the bed, lets the footboard drop and closes it up

little bit disappointed myself. We were cramped in the apartment, but the arrangement of rooms in the usual duplex seemed to offer no relief from that. Also, I couldn't help but admit that the other objections John had raised were sound.

AND then all at once a thought struck me: Just because the room arrangement in all the duplex apartments we'd seen was unsatisfactory, it was no reason why *our* duplex should have an unsatisfactory floor plan! What was to prevent us from designing a duplex of our own, and eliminating the objectionable features?

I expressed this thought to John.

He merely laughed at me.

"Who told you you were an architect?" he demanded.

"Nobody," I said; "but I'm going to design a new kind of duplex."

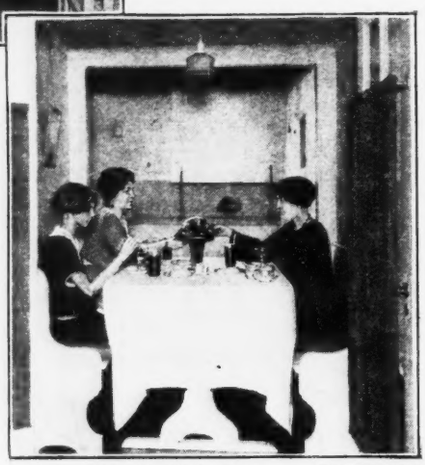
And I did—and we're living in it today.

It wasn't done as quickly as all that. My first rough sketches, I'm afraid, were quite impossible. But there was an idea behind them, and when I showed them to John, he became so interested that he volunteered to help me, and between us we worked out the problem.

The first thing we did was to provide a bedroom that was to be a bedroom and nothing else. The rear seemed to be the logical place to put it, so that's where it went. Since the bathroom should be convenient to the bedroom, the obvious location for it was next to the bedroom, so that's where *that* went—toward the front of the house. Next came the kitchen; then—well, what was the front room to be—living-room or dining-room, or a combination of both? It was quite a problem, and its solution required much more ingenuity than either of us suspected we possessed.

We decided at last that the front room was to be a living-room, and that we'd dispense with a dining-room entirely. Moreover, we eliminated the dining-room without subjecting ourselves to the unpleasant necessity of eating in the kitchen, for between kitchen and living-room we placed a most charming "breakfast nook," easily accessible from both living-room and kitchen, yet quite removed from all kitchen "clutter."

Beside this, at the center of the back wall of the living-room we placed a ventilated bed closet. By day there is nothing in the



A cozy dining-nook between the living-room and kitchen. Double French doors separate it from the living-room if desired. The table folds up

appearance of the living-room to denote that, when we have a guest, it can become a bedroom at night. Yet the bed turns easily out of its closet on its heavy door, and behind it appears a roomy, ventilated, electric-lighted dressing-room. There are clothes hooks, ample shelf space for suitcase, and a full-length mirror on the inside of a door that leads into a service hall.

That service hall we regard as the crowning achievement of our venture into architecture. Probably more than any other feature of our duplex, it makes the apartments—ours and our tenant's—real homes. And very easily, too, we arranged for it, once the idea of providing a hall occurred!

We merely cut a four-foot strip from the inner side of kitchen and bathroom — space that could be spared easily—and behold! there was the hall, with a door leading into each room! No necessity of crossing one room to reach another! At the ends of the hall are French doors, admitting light whether closed or open.

That, in a few words, describes the general plan of our duplex. The feature that has attracted the most comment from visitors is the breakfast nook, which we use for all meals. When the double French doors at the living-room end are thrown open, the nook becomes a part of the living-room, and gives an appearance of spaciousness that is quite amazing. Closed, the gauze drapes on the glass doors conceal the table and benches from view. The nook then is part of the kitchen.

When necessary, one leaf of the table, which is portable, may be dropped, thus affording a passageway between living-room and kitchen.

JOHN'S comfort received first consideration when we planned the bathroom. Two windows, with a shaving cabinet and a large mirror between, and an electric light above, give him all the light he needs for shaving. A towel cabinet beneath the mirror supplies John with a dressing-table.

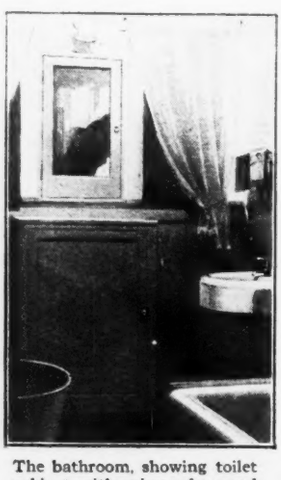
Five windows in our rear bedroom give us sufficient reason for calling it, as we do, a "sleeping porch." It is light, airy, quiet—has all the advantages a bedroom should have. The wall bed is easily put out of the way during the day.

In the kitchen are drawers and cupboards aplenty. A "cooler"—a tall cupboard with heavy wire shelves, vented top and bottom, holds vegetables, milk and similar supplies. There is a built-in ironing-board that folds down near the white-enameled gas-range, allowing plenty of room for ironing.

This small but convenient enameled kitchen has plenty of drawers and cupboards, as well as a built-in ironing-board that folds down near the gas-range, when it is to be used

We also have supplied abundant closet room. The dressing-room behind the wall bed of the living-room supplies an admirable clothes closet. There is a linen closet in the hall, also a broom closet large enough to contain the entire cleaning equipment of the apartment. We have a rear porch, containing a wash tray. There are inside steps to the small cemented basement, and an automatic gas-heater that supplies hot water in kitchen, bath, and wash tray. A combination bookcase and desk is built into the living-room.

IF YOU'RE tired of paying out rent, or desire to live in your own home for any other reason, I commend to you a duplex bungalow of the kind that John and I built. If the duplex plan has not yet reached your section, don't discard it for that reason. Maybe you can start the style in your town and win fame for yourself while you are building your home!

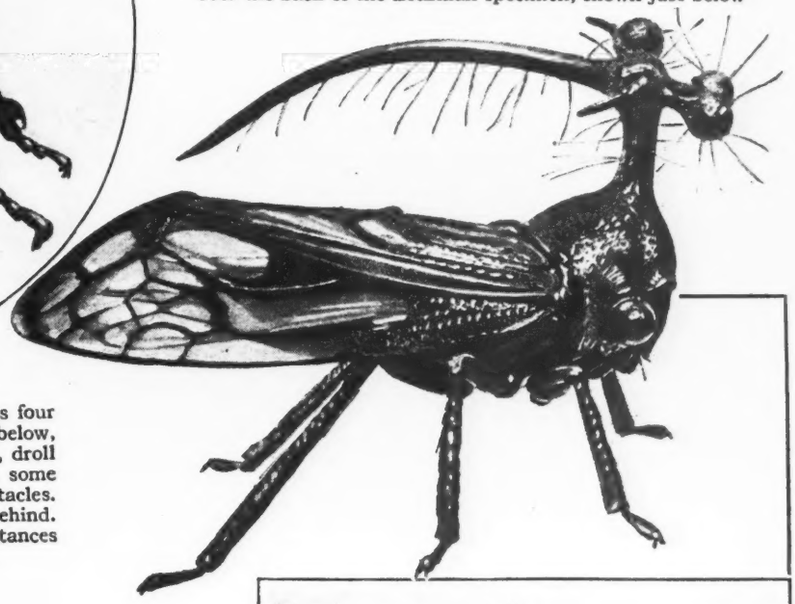


The bathroom, showing toilet cabinet with mirror door and roomy towel cabinet below

Insect Hobgoblins of the Tropics

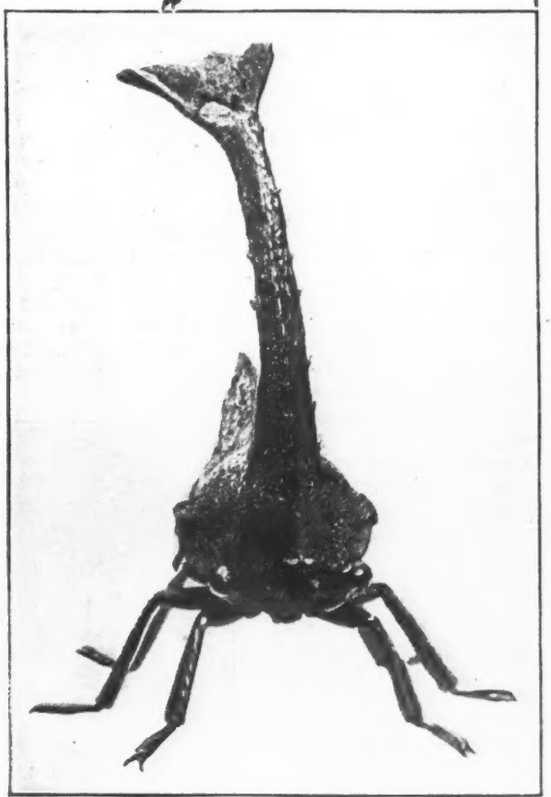
Midget Tree-Hoppers Show Nature in Fantastic Mood

Tree-hoppers of India and South America are the newest insect wonders presented to the public by science. They are tiny and gorgeously colored, and probably the most grotesque creatures that ever came under the microscope. The pictures on this page are from greatly enlarged wax models prepared at the American Museum of Natural History. Note the intricate, swordlike horn curving over the back of the Brazilian specimen, shown just below

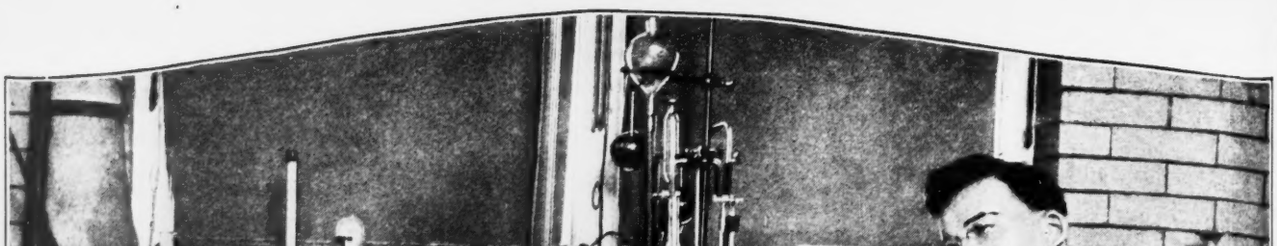


This specimen also is a native of Brazil. It has four eyes—two large protruding upper ones, and two below, partly developed. The upper eyes have a keen, droll look, and the line that separates the head in some instances gives it the appearance of wearing spectacles. It has three pairs of legs, the longer being behind. With these it is able to jump considerable distances

This insect, from India, suggests a turkey glancing backward. It has an anvil-shaped hump on its back. Underneath are the wings. Entomologists have not been able to tell why these specimens need horns that seem to be only in the way. These hoppers are the greatest change artists on nature's stage. They possess the amazingly useful power of altering their shape and size from day to day



With its unusually long appendage this Indian specimen bears a striking resemblance to a giraffe. Note its eyes just above where the legs join the body. They suggest automobile headlights. This creature is even more clumsy in its movements than some of the other awkward tree-hoppers



In the laboratory of the U. S. Bureau of Chemistry—making excellent tea from the leaves of the wild cassina plant

How Chemistry Is Feeding Us

MORE and more the world is coming to realize to what a startling and almost incredible degree the application of scientific knowledge has changed the aspect of productive industries. Back of our modern engineering and mechanical marvels, our automobiles, skyscrapers, airplanes, and bridges, stands the scientist, working in his laboratory to supply the materials of new and improved quality without which the triumphs of the engineer would be impossible.

In every direction eager experimenters are on the track of new discoveries. In seeking ways to eliminate waste in the production of power, they are searching radio-activity and the atom for new sources of energy. Likewise, to meet the world's demand for food, they are studying new methods of increasing the productivity of the soil and of eliminating waste effort on the farms.

It is this last field of research—science on the farm—that Doctor Hendrick discusses here. His is a fascinating and authoritative article on the achievements of synthetic chemistry in answer to man-made demands. — THE EDITOR.

By Ellwood Hendrick, Sc.D.

THERE used to be a play called "The Old Homestead" that was very popular. In it *Josh Whitcomb*, a sweet-natured and unsophisticated old farmer from Swazey, N. H., went to New York to look after a boy. The marvels of the great city had their effect on him. Having written home, he asked a passing stranger to direct him to the post-office so that he might dispatch his letter. The stranger pointed out a mail-box, and said if he deposited it there it would surely reach its destination.

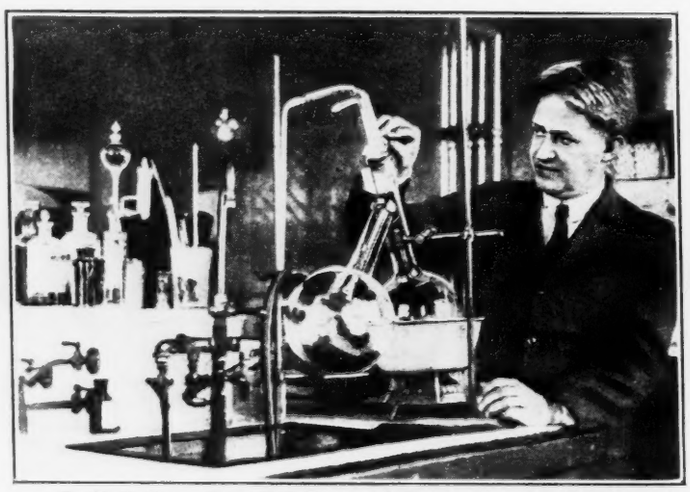
The farmer followed the advice; then, turning slowly away, he exclaimed, "Now, by gracious, I suppose that letter is halfway up to Swazey!"

Now we, who used to chortle at the credulity of the old man in the play, very often are like him when the talk is about science. There are some of us, for example, who believe that we soon shall have all our food made in chemical factories out of air and water and carbonic-acid gas; that even farming soon is to be a thing of the past, and that chemically prepared food will come to us in tablets that we shall nibble.

These notions are mere guesses, unsound economically. The farm is not to be supplanted by the chemical factory, although the farm already is beginning to draft the chemical and biological laboratories for its own purposes.

Even if we chemists could make up tasty and nutritious foods out of inanimate matter, instead of out of things that have been through the processes of life, out of things that have grown on the farm—and it's a fact, we don't know how to do it—there isn't power enough available to make the food for the world in factories. We should require coal or water power or fuel oil, while the plants and trees use the power of light direct from the sun for their growth. We cannot use light for power. Every green leaf has us beaten in this respect.

Again, our internal organs are so constructed that if we undertook to live on tablets without the necessary roughage or coarseness of food, they would collapse and the whole world soon would come down with an international bowel complaint. Let's keep our feet on the ground. Men of science have to do so.



Dr. H. C. Gore, of the U. S. Bureau of Chemistry, converting corn into a new sugar cheaper than cane sugar and sweeter than glucose

BUT don't be disappointed. Science, working along practical lines, already is accomplishing amazing things in solving our food problems. Consider, for example, the problem of obtaining nitrogen fertilizer so vital to our farms. Four-fifths of the air is nitrogen and plants must have nitrogen in combination—fixed nitrogen, as it is called—to grow. Now nitrogen fertilizer from the air already is being made on a large scale in Germany. Also, Dr. A. Larson, of the U. S. Government's Fixed Nitro-

gen Research laboratory, has worked out a process that is nearly doubly as effective as the German method.

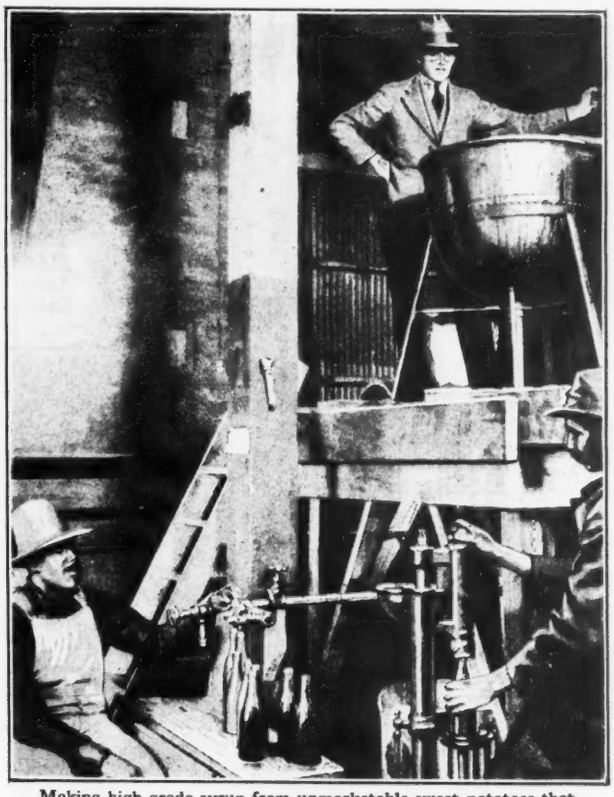
Another problem in connection with fertilizers is that of mixing them. Farmers haven't been able to do this very well, and so have paid freight on 20 per cent fertilizers mixed with 80 per cent gypsum or earth. But the farmer is coming around to mixing the necessary chemicals himself. Think of his saving on freights when he does!

AGAIN, instead of making "superphosphate" fertilizer out of finely ground phosphate rock and sulphuric acid, one concern is extracting the phosphoric acid from the rock, avoiding the waste by washing, using the lean as well as the rich rocks, and getting the pure white crystals available for use.

Humus, the result of decayed vegetable matter in a state of very fine particles, is another product greatly needed by the soil for the vigorous growth of plants. Now the prospect is fair that within a few years the sewage problem will be solved. That is, the sewage of cities and towns, instead of polluting streams and threatening public health, will have all grease separated from it, because grease destroys the fertility of soil. It then will be divided mechanically between fluid and solid, the fluid chlorinated and rendered wholly harmless, so that it does no damage even to the fish in the streams. The sludge, or solid will be so treated and dried that it becomes an odorless, inoffensive, low nitrogen fertilizer that is ideal for mixing with other chemicals.

Another very valuable source of humus will come from a process under development at the Rothamstead Experiment Station in England. Straw, chaff, stalks, and other farm waste is fermented by means of a special enzyme, or yeast, and in two or three months turns into an ideal humus, fairly rich in nitrogen. Straw now is burnt as waste on the great wheat farms.

Such scientific feats demonstrate how much may be expected from our chemists in making food indirectly from waste stuffs. So also does the way in which carbon-dioxide from the stacks of blast furnaces is being piped to farms and so made to increase the yield of crops.



Making high grade syrup from unmarketable sweet potatoes that formerly represented a waste of about 40 per cent of the entire crop. In the process developed by government chemists, the potatoes are boiled, treated with a little malt, and crushed until they yield a juice that is reduced by evaporation to a syrup resembling cane syrup

The leaves of plants and trees take in water vapor and carbonic-acid gas from the air and by a remarkable chemical process, using the light of the sun for energy, resolve these two vapors into the principal constituents of the plant, giving back oxygen to the air. In iron blast furnaces the exhaust gases contain large quantities of carbonic-acid gas that put out fire, together with other gases that will burn. It is profitable to separate the carbonic-acid gas from the others, using the latter as fuel. But instead of wasting the carbonic-acid gas, it can be flooded over neighboring truck gardens, and thus cause a luxuriant growth of vegetation.

Industrial alcohol works also produce vast quantities of this gas, and it may become profitable to produce it locally if limestone is available and if near by is some industrial establishment that produces a waste acid.

SO MUCH for making the soil more productive. In the meantime it is well to bear in mind, to the credit of the American farmer, that in the 20 years following 1900, he not only fed and clothed the American people, but exported wheat and other grains, allayed starvation in China and Russia; and this despite the fact that at the end of the period he was cultivating 11 per cent less acreage than at the beginning, with 33 per cent fewer persons to work for him; for within that time some 4,000,000 workers transferred their activities from agriculture to industry. We mustn't kick if the farmer is a little slow in adopting some improvements. He is short-handed.

One important means of conserving the food we produce lies in canning. The American Canners' Association maintains a large research laboratory in Washington where improvements in factory methods, in the taste and keeping qualities of food products, and the avoidance of waste, are worked out. Canning alone saves a vast tonnage of fruits and vegetables every season.

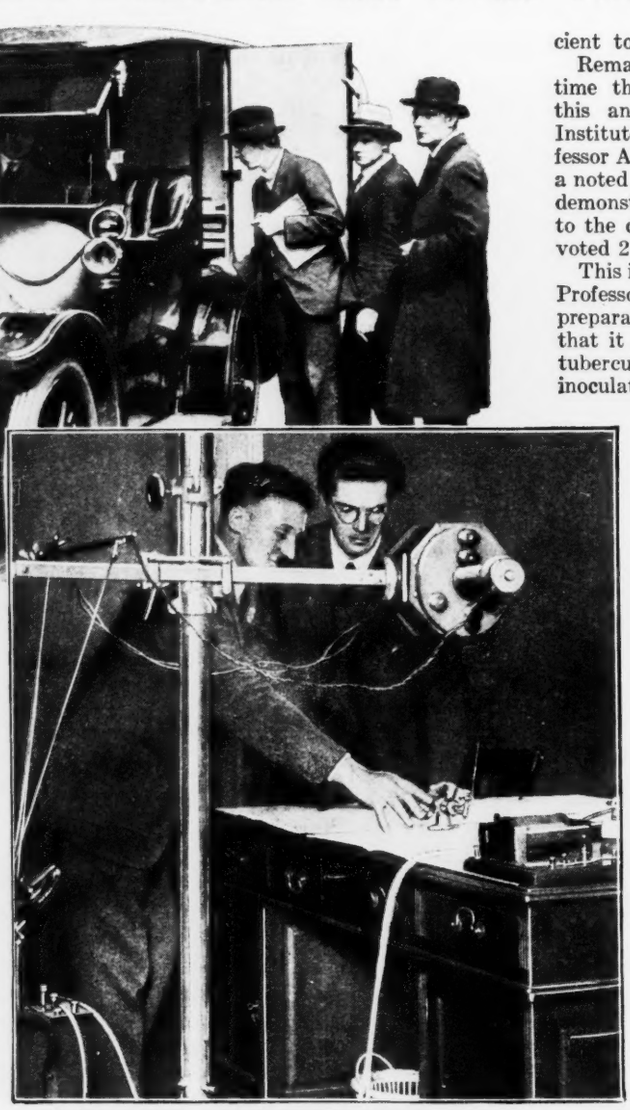
(*Continued on page 131*)

Chemistry has supplanted the "rule of thumb" in the flour industry. In the old days the miller felt the flour between his forefinger and thumb to determine its quality and texture. Today elaborate chemical laboratories are part of every great milling plant. Here flour is tested for nutritive values, and deficiencies are remedied, with the object of making each slice of bread a perfectly balanced ration of food. The woman in the picture is testing the ash of burnt flour in a New York flour mill and is one of a large staff of expert chemists who are regularly employed by the mill

Practical Science in the Making

A Review of Recent Discoveries and What They Hold for You

The X-ray has been made available for home use by a portable apparatus transported by automobile. Power from a dynamo mounted on the hood of the car is supplied through a cable taken into the house



Experimenters operating the portable X-ray apparatus, invented by Prof. A. M. Low, noted British scientist, to examine the quality of metal in a carburetor

CARBON dioxide, or carbonic-acid gas, may be described as the "smoke" of the body fires. We exhale it from our lungs as "waste" after the oxygen we have previously absorbed has been utilized in the "burning" process that replenishes the tissues. It is carbon dioxide issuing from many lungs that causes theaters and similar gathering places of many people to become "stuffy." Carbon dioxide will not support animal life. In fact, in a concentration of four or five per cent in the atmosphere it may be fatal.

It is somewhat amazing, then, to learn that science has discovered that this gas, which will itself asphyxiate, is more potent than fresh air or even oxygen in reviving partially asphyxiated persons. And quite as astonishing is the suggestion recently made that this gas can be used to cure tuberculosis.

The value of carbon dioxide in cases of suffocation is made known by Professor Yandell Henderson, of Yale University. The gas is normally present in the lungs and blood where, Professor Henderson says, it is necessary to stimulate the nerve centers that control breathing. Fresh air or pure oxygen administered to a victim of asphyxiation, he asserts, tends to depress the nerve centers of respiration and make breathing more difficult instead of improving it.

NOR is this merely a theory, for Professor Henderson and his associate, Dr. H. W. Haggard, have devised a breathing apparatus that automatically mixes about five per cent of carbon dioxide in the air supplied to a suffocated person. The effect is said to be a remarkable stimulation of breathing, so much so that victims of illuminating gas, carbon monoxide, and smoke, and surgical patients after anesthesia recover entirely in a few hours.

Dr. H. J. Cooper, tuberculosis authority, of Denver, Colo., asserts that carbon dioxide may furnish a cure for tuberculosis. Experiments with thousands of animals, according to Doctor Cooper, show that the growth of tubercle bacilli is arrested by three per cent carbon dioxide, while the bacilli are killed by 15 per cent.

It is Doctor Cooper's suggestion that the injection of carbon into the blood, in quantities so minute that the tiny blood vessels will not be blocked, will result in the depositing of carbon in the lungs and consequent formation there of carbon dioxide in amounts sufficient to kill the germs of tuberculosis.

Remarkably enough, at just about the time that Doctor Cooper was making this announcement, from the Pasteur Institute in Paris came word that Professor Albert Calmette, assistant director, a noted tuberculosis expert, was ready to demonstrate an anti-tuberculosis vaccine to the development of which he had devoted 20 years.

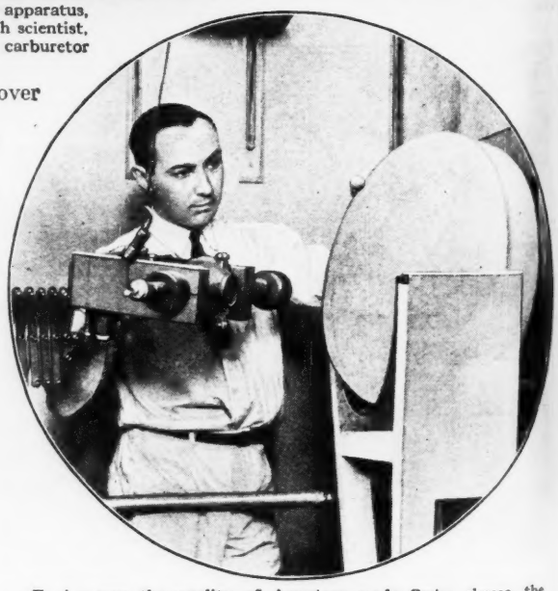
This is not a tuberculosis cure. All that Professor Calmette promises for his preparation, which he calls "B C G," is that it will prevent the development of tuberculosis germs in persons who are inoculated with it.

Tuberculosis is one of the few germ diseases that medical science has not yet conquered. Efforts such as those just described, however, undoubtedly will result in the control and eventual elimination of it.

Gun Ejects Airplane

SHOOTING an airplane out of a gun probably sounds like some imaginative novelist's suggestion, yet just exactly that was done in a scientific test of a new method of putting aircraft into flight, conducted a few weeks ago at the Naval Air Station, Washington, D. C. Before long this may become the standard method of launching airplanes from war-ship decks.

The plane is placed on a small car, mounted on tracks that end at a platform on top of a battleship's turret. The car is connected by a series of pulleys with a piston inclosed in a gun. When the gun is fired, the piston is driven forward, pulling the car almost instantly into a speed of



To improve the quality of American-made Swiss cheese, the U. S. Bureau of Standards has perfected this cheese-testing X-ray device. A dairy expert of the Bureau is shown examining a cheese to determine whether it has aged sufficiently

60 miles an hour. At the end of the tracks hydraulic and spring buffers stop the car, and the plane is catapulted off, continuing under its own power.

This method is said to be superior to the compressed-air catapults previously used. The plane continues its flight with no drop in altitude, probably because a charge of powder supplies greater momentum than the compressed air.

Also, it permits the launching of planes one after the other as fast as the gun can be reloaded and the planes set on the car.

A New Helicopter

THE British Government, according to recent reports, is making a determined effort to develop a practicable helicopter. Several British inventors have tackled the problem under the auspices of the Air Ministry, and one of them, Louis Brennan, is said to have devised a machine that can rise and descend in perfect control.

Tests of the machine have been made in secret.

Despite precautions, word has been received that the machine is capable of rising 25 feet or more, hovering for a considerable period and landing unhurt.

The Brennan machine has not been tested in horizontal flight.

Explorers' School

FOR explorers, experience always has been not only the best, but the only teacher. No college offered a course in exploration until recently, when the American Geographical Society established a school for explorers in New York City. Dr. Hamilton Rice, well known South American explorer, conceived the idea of the school, and is its director.

The scheme of instruction will be entirely practical, based on the experience of noted explorers. Of course, in the country around New York, where field instructions will be given, the students will not experience the rigors of the jungle or the arctic regions, but the conditions of actual exploration will be simulated as well as possible. Thorough instruction will be given in surveying, mapping, and field astronomy.

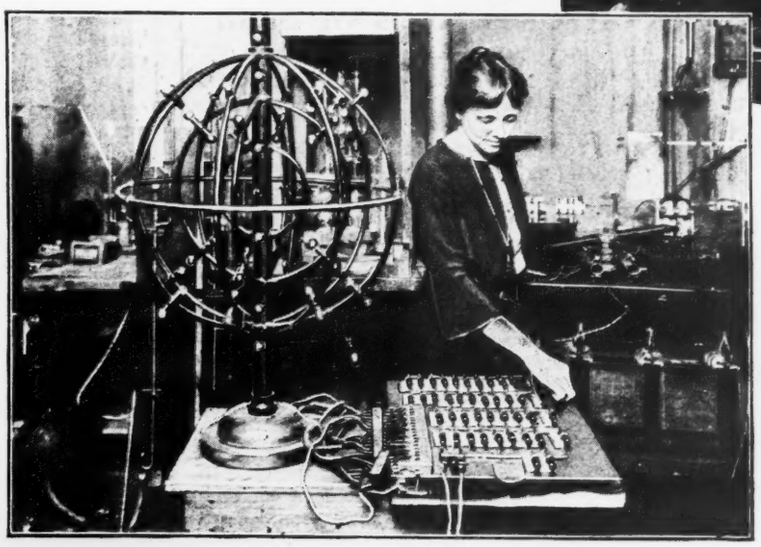
Science Finds a Way

SOME time ago scientists from the Smithsonian Institution established a meteorological station on a mountain in Chile. The purpose was to measure the heat of the sun to discover what relation exists between changes in the sun's heat and our weather.

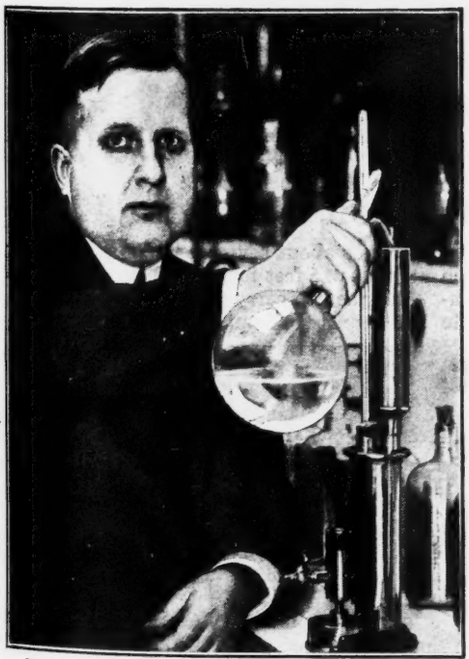
Elaborate mathematical calculations were performed mostly at night, for during the day the scientists were engaged in making observations. The primitive oil lamps and candles that were the only means at hand for supplying light for the night work were unsatisfactory to scientists who were accustomed to working in well equipped laboratories. The necessity for electric lights was apparent—but how were they to get them at the peak of a desolate mountain?

Recently they found a way. They built a windmill, installed a dynamo and storage batteries, and now their observatory, hundreds of miles from the nearest inhabited place, is as well lighted as if it were in the heart of civilization.

Thus does science triumph over obstacles large and small.



To demonstrate the theory that atoms of matter are composed of electrons revolving, like planets in a solar system, around a central nucleus, the General Electric Company has installed in its research laboratory the model atom shown above. The electrons are indicated by small electric lights. Thus the theoretical arrangement of electrons in an atom of any given substance can be visualized



Here is Dr. William V. Linder, chief chemist of the United States Bureau of Chemistry, under whose direction 80,000 samples of bootleg liquor have been analyzed by Uncle Sam this year. Of these, 72,000—or nine out of 10 samples—were found to contain poisons, including carbolic acid, hydrochloric acid, formaldehyde, acetone, and iodine

Prof. F. B. Littell, of the United States Navy, using the world's most perfect zenith tube at the Naval Observatory, Washington, D. C., to measure variations in latitude in the earth's movement

© Harris & Ewing

From measurements with the zenith tube at Washington, and from observations at other astronomical observatories, it has been determined that the axis of the earth's rotation changes its position continually. The North Pole moves around in a circle varying from 30 to 60 feet in diameter, completing the circuit in about 14 months

Reducing Weight

STOUT persons, anxious to "reduce," usually make a special point of avoiding sweets. This is a mistake, according to Dr. James McLester, of Birmingham, Ala., who says that sweets offer a valuable weapon to those who would lose weight.

Too much food, says Doctor McLester, is the usual cause of corpulence, and a slim diet offers the obvious remedy. A scant meal, though, he says, does not seem so scant if brought to an end with a dessert, and he recommends the practice of following lean meals with sweets as an aid to perseverance with a "reducing" diet.

However, he advises against attempting to reduce the weight too rapidly. "A loss of three to six pounds a month," he says, "when continued sufficiently long, obviously will bring the weight to any desired figure."

Radio Storm Warnings

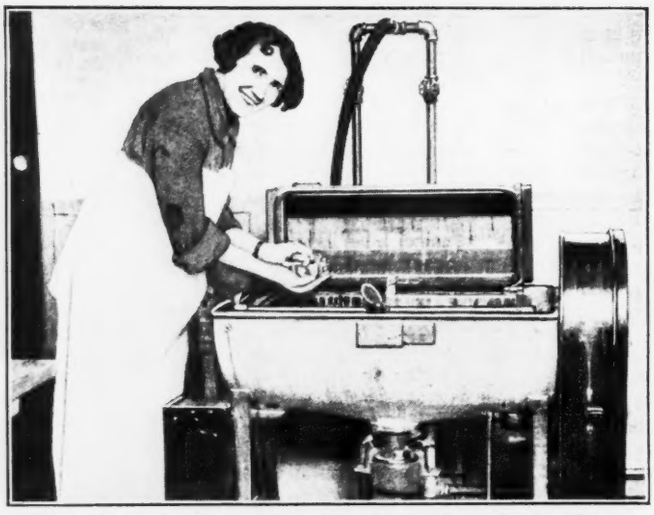
STORM warnings for ships sailing the northern seas shortly will be available from four radio stations to be established in Greenland by the Danish Parliament. One of these will be erected on the eastern coast, the others on the western coast.

The eastern station, at Angmagsalik, will be especially useful for meteorological observations, because of its location in the path of storms that sweep the coast.

Money Cleansed by a Washing Machine

THE term "filthy lucre" has been banned from the English language as far as a certain Los Angeles hotel is concerned, by the installation of a coin-washing machine in which all money received by the hostelry is cleansed before being returned to the guests in the form of change.

A rule is in effect in this particular hotel that no money that has not been washed and made sanitary and new in appearance is to be given out by cashiers, waiters, and other employees to the hotel guests.



How the used coins are cleaned in the hotel washing machine

Garden Table Folds like Umbrella

AN INGENIOUS table intended for garden use or for card games in the house, folds into a space about a foot long and three inches wide. The collapsible canvas top of the table folds on the principle of an umbrella, by the sliding of a ring carrying umbrella-like ribs. The longer ribs are straight, to make the top of the table flat.

The center post of the table comes in two sections, held in position by a slot in one section in which pins in the other section engage. Three spreading legs of tubing are attached to an aluminum casting at the foot of the center post. These legs are all the same length, but of three different diameters so that they can fit one inside the other. To a collar on the center post are attached four rings that serve to hold drinking glasses in the event of the table's being requisitioned for card-playing.

The folding table ready for use

Compact Stereopticon Uses Rolls of Film

UNUSUALLY compact and easy to operate is a new type of still-picture projector that uses miniature views on strips of film similar to motion-picture film, instead of the usual cumbersome glass plates. Each film strip contains from 50 to 500 pictures.

The projector is 10½ inches in height and weighs only 4½ pounds. It uses a standard incandescent electric globe, with a special resistance cord that makes it adaptable to any electric-light connection.

By means of a special insulating device the film is protected from the heat of the lamp so that a single picture may remain on the screen for hours. Or, if desired, more than a hundred pictures can be shown in a minute.

The new stereopticon, showing film rolls

A Telephone for the Deaf

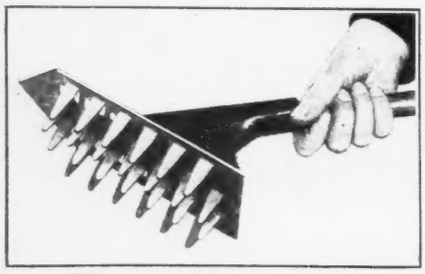
USE of the cheekbone as a conductor to the auditory nerve, coupled with the amplification of speech, is reported to be the secret of a telephone for the deaf that has been put to test use by the Saskatchewan Government Department of Telephones.

It is reported that persons who have been unable to hear for years have been able to hear long-distance calls.

Small Hand Tiller Useful for the Home Garden

FOR breaking up clods of earth and smoothing the newly dug garden surface, a new garden hand tool, known as a tiller, has been invented. It should be used with a hammering and spreading action.

The pointed front of the tiller can be used for making a furrow for seeding.

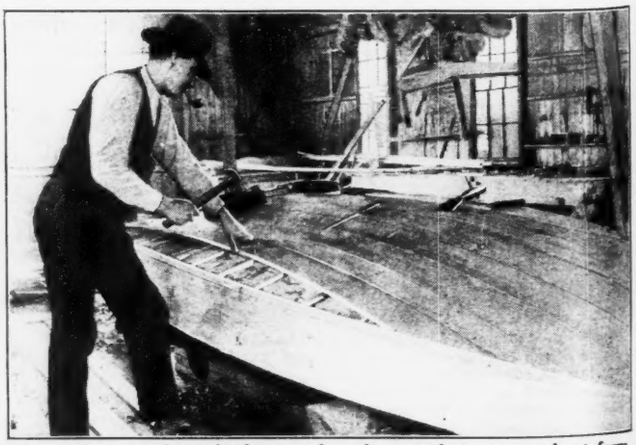


This hand tool harrows the soil

Wooden Catboats Built on Concrete Forms

AN EASTERN manufacturer of catboats uses a concrete form on which to assemble them, thus cutting his finishing time in half and assuring complete uniformity.

Slots in the concrete are provided for the cross pieces, to which are nailed the centerboard, sides, and bottom boards of the boat. The block not only provides a solid working base to hammer against, but enables the builder to keep the construction uniform and true without the necessity of constant measurement. The concrete form weighs about seven tons. The completed boat is 15 feet long, six feet beam, and is designed to carry a 25-foot mast and 225 square feet of sail.

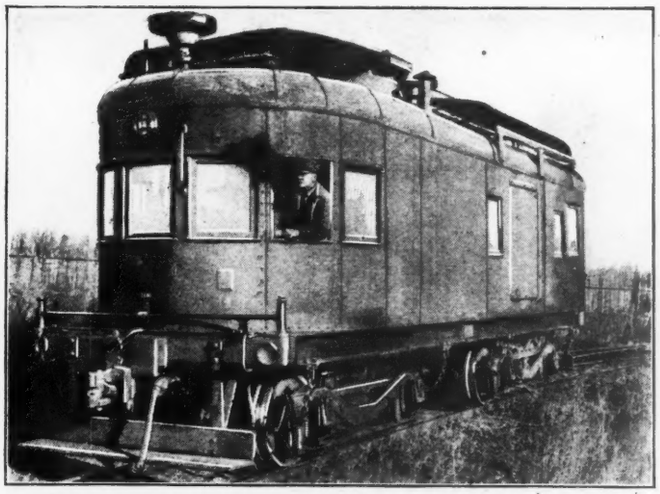


A workman nailing the bottom boards over the concrete boat form

New Locomotive Has Diesel Engine

THE first electric locomotive to use an oil engine of the Diesel type to drive a generator supplying electric power for the driving wheels has been completed by the General Electric Company and the Ingersoll Rand Company. It is designed for switching service and consumes from 20 to 26 cents worth of fuel an hour. This is approximately one-third the cost of coal used by an ordinary steam switching engine.

The 300-horsepower, six-cylinder oil engine is directly connected with a 200-kilowatt generator. Four electric motors are used, one for each of four axles, providing remarkable flexibility. Sufficient fuel for 48 hours' continuous switching service can be carried, and there is no smoke. Like an auto, the engine need be operated only when the locomotive is being used.



Cooling radiator and exhaust muffler are located above the roof

Automatic Teller Takes Deposits

AN AUTOMATIC teller that receives paper money deposits and issues receipts for them is a new device designed to encourage saving among industrial employees. Bills of one-, two-, five-, or ten-dollar denominations are put into their proper slot. Pushing the handle directly beneath the slot produces a correct receipt for the money, which drops into a regulation safe below.

The machines are placed in industrial plants, where deposits may be made at any time. At the close of each workday the cash deposited by all employees is taken from the machine and re-deposited in a near-by bank. There each employee is given credit for the amount of his deposits when he shows his receipts.

The device is said to bring in many new savings accounts and increase deposits greatly.

Making a deposit in the machine

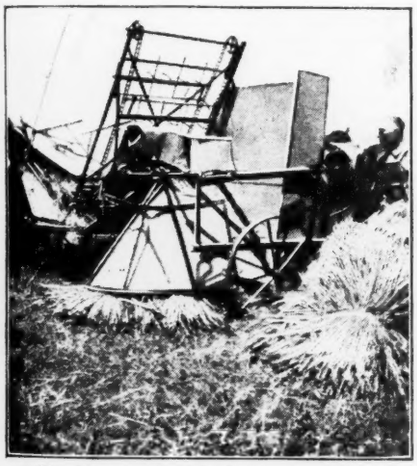
This Machine Cuts, Binds, and Shocks Grain

A MACHINE that not only cuts and binds grain, but deposits the bundles in shocks, has been developed for use in grain fields. The shocker is attached to the binder in place of the customary bundle carrier.

From the binder the grain is taken by means of an elevator to a basket consisting of two separate cone-shaped parts supported at the apex. While one section of the basket is in a vertical position being filled, the other part is carried horizontally.

In setting the shock, the operator engages a clutch that drives the upright member down on the sheaves, and moving the basket backward at the same rate the machine is moving forward, thus placing the butts firmly on the ground in an upright position. As one portion of the basket is setting the shock, the other turns into position for receiving new grain.

The shocker is graintight and is said to save enough loose grain in one year to pay for itself. It has few moving parts and its life is said to be twice that of an ordinary binder.



Shocking grain with the new machine

Salt Lake Man Has a Back-Yard Gas Plant

WHILE drilling a well to obtain a supply of drinking water, a resident on the outskirts of Salt Lake City, Utah, struck instead a well of natural gas. So he connected a 300-gallon tank with the gas flow and now uses it for heating, lighting, and cooking.

The tank, which holds a day's supply, fills within an hour, and the owner now can light and heat his home without the fear that a gas company will shut his meter if he fails to pay his bill.

Other residents of the neighborhood have drilled seeking similar wells, but thus far without success.

The back-yard gas tank that holds a day's supply of fuel

Bathing-Cap with Goggles Designed for Divers

FOR use by swimmers who wear glasses, and to permit a diver to see under water and still keep the water from his eyes, ears, and nose, an elastic rubber bathing-cap with goggles and coverings for the nose and ears has been invented by A. G. Johnson, of Washington, D. C.

Novel bathing-cap

The cap is so constructed that it prevents the entrance of water, yet allows the wearer to breathe freely through the mouth and talk without removing the headpiece.

Bird Is Model for Airplane Helicopter

A NOVEL model of a helicopter airplane, which the inventor claims will carry four times the weight of present types with one quarter of the power, has been patterned on some of the mechanical principles used by birds in flight. The upper and lower wings slope forward until they meet in a horizontal edge that cleaves the air.

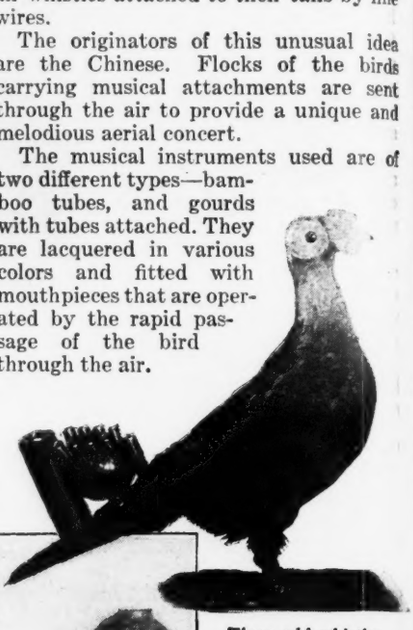
By opening the V-shaped wings and slowing down the motor, the inventor, Dr. H. T. Randle, of Lawrence, Kan., says the machine can land on any flat-roofed building.

Pigeons in Flight Whistle Concerts in the Sky

ONE of the queerest orchestras in the world plays music up in the sky. The players are members of a flock of pigeons, carrying various kinds of light air whistles attached to their tails by fine wires.

The originators of this unusual idea are the Chinese. Flocks of the birds carrying musical attachments are sent through the air to provide a unique and melodious aerial concert.

The musical instruments used are of two different types—bamboo tubes, and gourds with tubes attached. They are lacquered in various colors and fitted with mouthpieces that are operated by the rapid passage of the bird through the air.

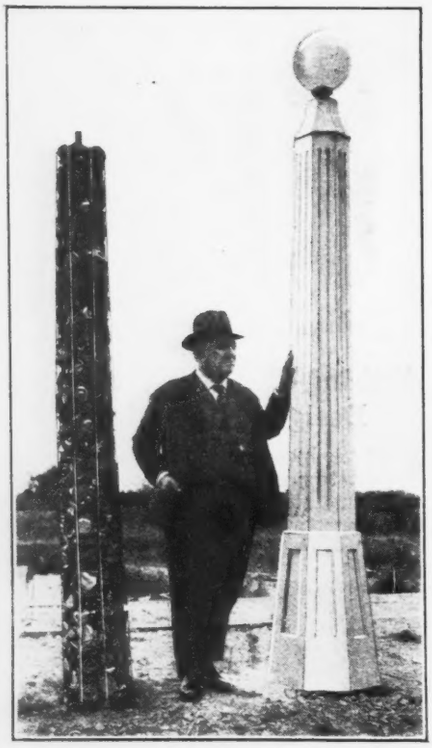


These odd whistles made by the Chinese from bamboo tubes and gourds are attached to the tails of pigeons by fine wires, as shown above. The swift flight of the birds through the air blows the whistles, producing a strange concert in the sky

Ornamental Lighting Posts Reinforced by Tin Cans

THE driveways and walks of San Antonio, Texas, are literally lined with tin cans, but not so that one may notice; for the cans are embodied in the electric-light posts.

Park Commissioner Ray Lambert originated the ingenious method of utilizing much of the city's waste tin-can output by using them for reinforcing ornamental concrete posts, as shown in the illustration. Conduits through the center of the posts carry the necessary wiring. The addition of a globe at the top completes an economical and ornamental lamp-post.



Giant Lobsters Caught off the Jersey Coast

TWO of the largest lobsters ever caught were taken recently from their deep-sea haunts and placed on exhibition in the New York Museum of Natural History.

The largest specimen weighed 34 pounds, was nearly three feet long, and was estimated to be 50 years old. It carried many scars on its body from fierce marine combats. The smaller one weighed 28 pounds.

The haunts of these two submarine marauders were off the Highlands of New Jersey, where their enormous strength and size enabled them to destroy and rob traps that were too small to catch them. They were finally brought to the surface clinging to the outside of an ordinary fish trap that they had been robbing.

When engaging in formidable combat lobsters are endowed with the ability to leave one or more claws in tight grasp of the enemy in order to escape. The lost members soon grow out again.

The two great lobsters compared in size with a six-year-old boy

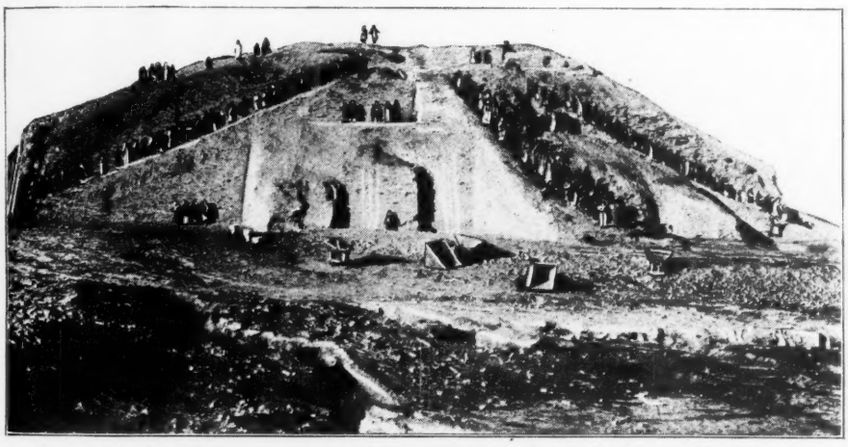
Duplicate of the Tower of Babel Unearthed

THE remains of the great tower of Ur of the Chaldees in lower Mesopotamia recently has been unearthed, giving a clear idea of what this *ziggurat* and its sister monument, the Tower of Babel, looked like when they were built. The Ur remains are more than 4000 years old. Ancient ruins in the vicinity go back to the dawn of history, and are among the earliest buildings known.

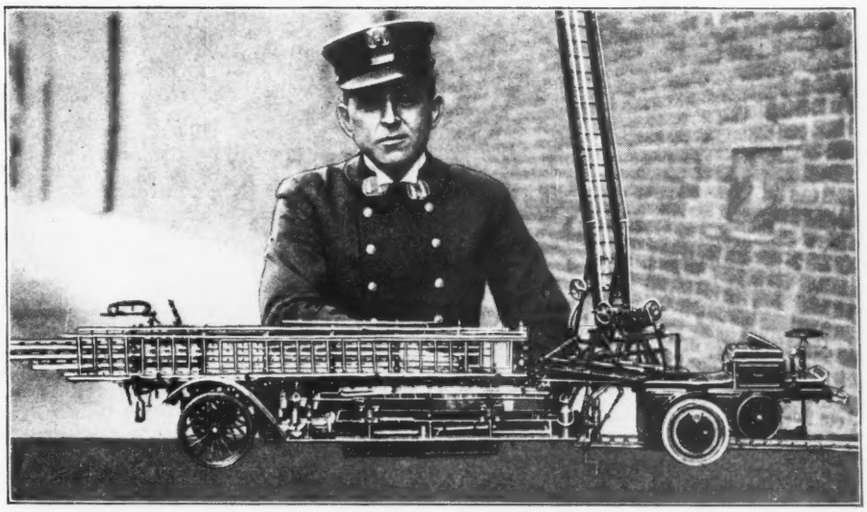
Two hundred natives were engaged in digging, the work being carried on jointly by the British Museum and the Museum of the University of Pennsylvania. Earlier excavations brought forth clay cylinders with inscriptions in which Nabonides, the last king of Babylon, told of finishing the tower, left unfinished by two kings of Ur, at about 2300 B.C.

The tower is solid throughout, with crude bricks inside covered with a facing of baked bricks laid in mortar. Reed mats dipped in pitch were laid between the bricks. Three sides of the tower are perpendicular. On the fourth huge stairs lead to the summit. As each brick bears the royal stamp, it is a simple matter to trace which kings had taken part in the building.

This is believed to have been one of many towers supposed to be imitations of the hills where the Sumerians worshipped their gods before they settled in the Tigris and Euphrates valleys.



Excavated ruins of the great tower of Ur, showing stairways leading to the summit



Miniature Fire-Engine Filed from Brass

A MINIATURE working model of a motorized hook and ladder, filed entirely by hand out of brass, recently was constructed by a fire captain in the Jersey City, N. J., fire department. It was modeled after the first piece of motor equipment installed in the department.

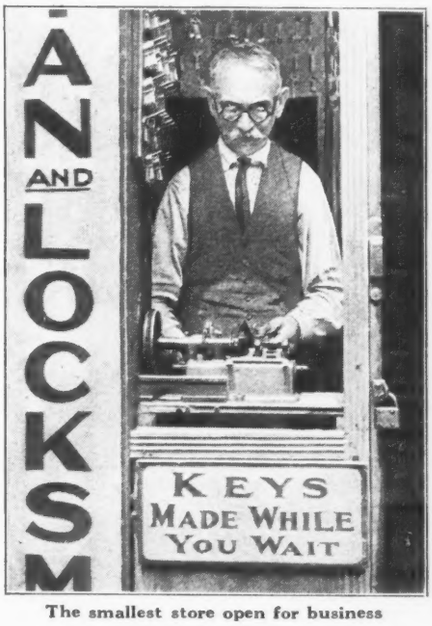
Practically every part of the real machine is embodied in the miniature, the only difference being that an electric motor is used instead of the gasoline engine employed in the original.

Smallest New York Store only Two Feet Wide

WHAT is said to be the smallest store in New York City, if not in the world, recently was opened for business by a locksmith, machinist, and electrician.

The width of the shop is 24 inches. It is so small that customers cannot enter, and business is transacted through the window in the front door.

The owner leaves by a door at the side that forms one wall of his unique establishment.

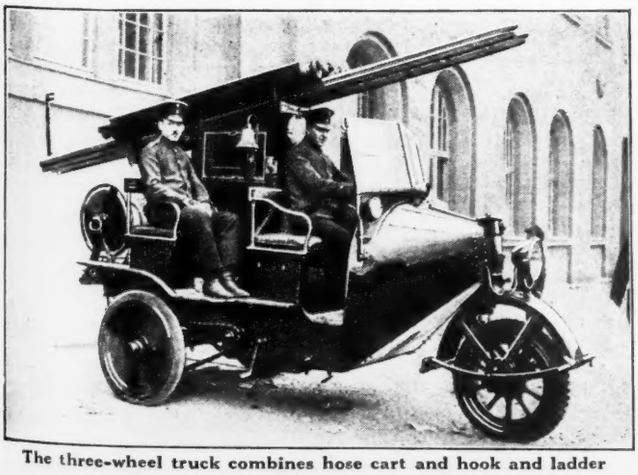


The smallest store open for business

Three-Wheel Fire-Truck for Small Towns

A NEW German fire-engine combining a hose cart and a small hook and ladder has only three wheels, one in front and two at the rear. A gasoline motor supplies the motive power. There is seating space for three men. The apparatus was turned out by the Krupp works. It was designed especially for use in small towns and villages where elaborate and expensive equipment is unnecessary. Since two fire-engines are combined in one, the cost of fire protection for small communities is practically cut in half.

The tricycle machine is said to be remarkably speedy and easy to operate.



The three-wheel truck combines hose cart and hook and ladder

Cow Bones for Chinese Game

THREE carloads of shinbones from cows slaughtered at a Chicago packing plant recently were shipped to China for use in manufacturing the popular tile game.

Cutting Steel with a Torch under Water

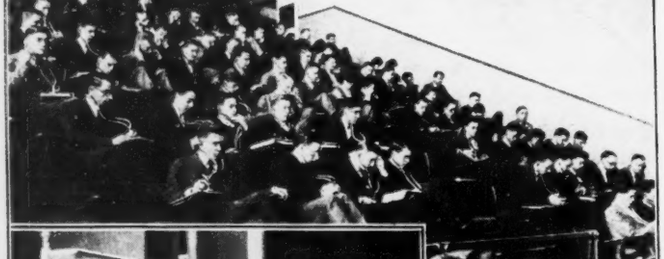
AT A scientific exposition in Paris recently was demonstrated a method for cutting steel under water with a torch. To the usual oxyacetylene torch is added a supplementary system of compressed air. This blows the water away from the mouth of the torch sufficiently to permit the oxyacetylene gas and its electric arc to function as usual.

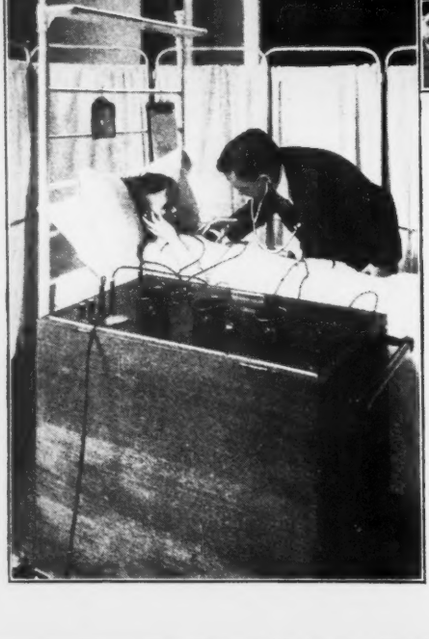
The diver carries the torch down with him on his descent, one end of its supply tubes being connected with a barge above. When the torch is removed from the cutting surface, the flame is cut off.

The effectiveness of the method depends on the depth of water and the thickness of the metal plates to be cut. As the depth increases, the pressure of compressed air must be increased greatly to maintain the force of the cutting flame.

New Stethophone "Broadcasts" Heartbeats

THROUGH the invention of a new electric stethophone, the human heartbeat now may be "broadcast" through a great number of instruments to listeners several feet away from the subject. The new machine amplifies the sound of the heartbeat three times.





Above: Five hundred physicians listening to amplified heartbeats. Left: A child listening to his own heartbeats

The electrical apparatus that does the amplifying is moved on a wheeled table similar to a tea-table.

It was demonstrated not long ago before 500 doctors attending the convention of the American Medical Association in Chicago, and promises soon to become a regular part of hospital fittings.

The Spectrum in Industry

THE spectrum, once used only by astronomers, now is beginning to play an important part in American industry. In the development of a method of spectral analysis of metals—a method perfected by the U. S. Bureau of Standards—an increasing number of industries are finding a valuable new aid in detecting impurities in metal products.

This system has been used with success in determining causes of boiler explosions, and in preparing purity standards of vanadium steel, platinum, rhodium, iridium, and palladium.

Subway Coin Machine Makes Change Automatically

ONE of the latest devices to expedite the movement of crowds in transportation is an automatic coin-changing machine introduced by a New York City rapid transit company. Without the aid of an attendant, it is said to change dimes, quarters, and half dollars into nickels more rapidly than any human change-maker could do it.

The photograph below shows Frank Hedley, president of the transit company, demonstrating one of the machines which, he says, eventually will be installed in 300 subway stations in which about 1200 attendants now are employed.

Simplicity of operation is one of the valuable features of the machine. At the top are three slots, marked 10, 25, and 50 cents. Above these is the instruction: "Insert money here." When the specified coin is deposited, the correct change for it is deposited automatically in a corresponding receptacle below.

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Demonstrating the automatic coin changer

Beneath each slot is a lens that magnifies the deposited coin four times, so that the coin may be seen both by passengers and by the attending guard. This is to aid in the detection of slugs or counterfeit coins.

An Automatic Nailer

GREATER speed and convenience in nailing roofing is provided by a device that automatically places nails up to 1½ inches long in position to be driven in.

The machine consists of an iron frame holding a nail box from which the nails are fed down an inclined carrier.

A catch holds each nail in position for hammering.

Laying roofing with the nail machine

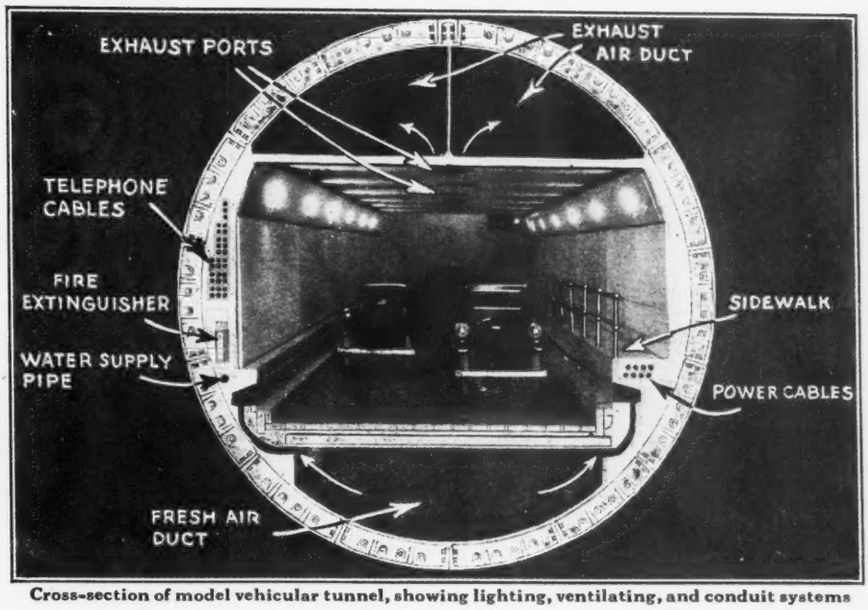
Miniature Tunnel Built for Lighting Tests

TO DETERMINE the most effective way of lighting the twin vehicular tunnels now being built under the Hudson River, engineers of the Westinghouse Lamp Company recently constructed a miniature model of a tunnel section, complete to the tiny automobiles representing vehicular traffic.

Ample light without either glare or sharp shadows was the desired goal. After numerous experiments with the model, specially designed reflectors were set in iron boxes embedded in the wall on each side near the ceiling, the light being directed downward at an angle of 20 degrees. With the addition of diffusing glass covering the reflector mouth to prevent glare, this arrangement solved the problem.

Two thousand of these special lighting units will be used, spaced at 20-foot intervals. Illumination three times greater than that on the average city street at night is said to have been achieved.

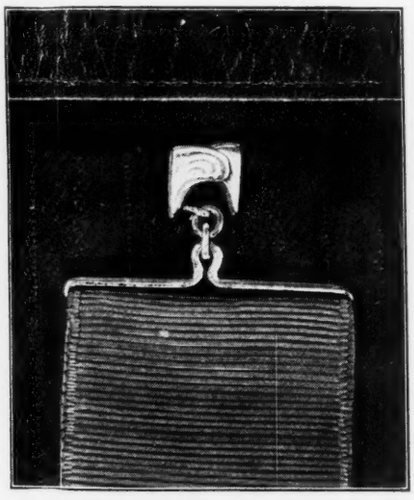
The model is on a scale of one inch to one foot. It represents a tunnel section 120 feet long, being itself 10 feet long and 29 inches in diameter. The exact intensity of light to be used in the real tunnels is used in it. Signs around the mouth of the model explain the engineering features of the tube, chief of which is the ventilating system.



Cross-section of model vehicular tunnel, showing lighting, ventilating, and conduit systems

This, designed to meet the special difficulty of exhaust gas, supplies fresh air through flues from a large duct beneath the roadway and removes vitiated air through ports to an equally large duct above the roadway.

Each of the twin tunnels, one for east and one for west traffic, will have room for two parallel lines of automobiles, the roadway being 20 feet wide. One side will be for slower vehicles, like trucks. Each tunnel will be 1¾ miles long. They are expected to be ready for use early in 1926.



This Simple Pocket Catch Safeguards Your Watch

A CATCH with two tiny metal fingers secreted at the top of the trousers watch pocket has been devised to guard timepieces from slipping out and dropping to the floor when the trousers are hung upside down.

A neatly concealed spring base plate is inserted on the inner side of the watch pocket. Spring fingers run along the top of the pocket and meet at the center, closing over the watch chain. When the watch is in place, it is securely held in an upright position so that the trousers may be shaken and folded without any danger that the watch will fly out and crash to the floor.

When the watch is to be removed, pressure on the inner spring separates the fingers far enough to permit the chain to pass through. This can be done quickly, with a simple movement of the fingers.

Ornamental Telescope for Lawn or Garden

A BRONZE reflecting telescope permanently mounted for home use and possessing beauty of design that harmonizes perfectly with a garden or lawn setting, now is available for persons who have made or would like to make the study of the stars their hobby. The instrument also can serve as a sun clock.

The conventional telescope design must be taken down and carried indoors when the evening's observations are done. When it is brought out again, it must be set up on its tripod and carefully adjusted. The new garden telescope, on the other hand, is a permanent fixture on the lawn, always ready for use.

The tube of the usual telescope serves solely to hold the prism and eyepiece rigidly in their proper relation to the concave mirror that catches the light. In the new design, the mirror is on a decorated hollow hemisphere, lead-filled for counterpoising. A curved, solid arm carrying the prism and eyepiece, ascends from the hemisphere. This swings freely on trunnions. Thus the reflected light passes through free air to the prism. An additional eyepiece allows observation by two persons simultaneously.

The telescope is swung between its supports within a hollow member resembling an upturned bell. Part of this bell is cut away, permitting the arm to swing so that any part of the heavens can be observed.

Above is shown the artistic new reflecting telescope permanently mounted on its ornamental pedestal in the garden. At the left is a close-up view of the instrument, showing the arrangement of the concave silvered glass mirror, the right-angled prism, and eyepiece

Surface Turntable for Railway Motor-Cars

THE increased use of gasoline motor-cars for passenger service has created a need for turntables at many points where there are no shops or facilities for turning cars.

To meet this need a special turntable has been devised that needs no pit under ordinary conditions, and that may be moved easily whenever desired. This effects a reduction in cost and installation.

The equipment consists of a circular foundation rail on which rides the turning section supporting the tracks. The distance from the top to bottom rail is only 21⅛ inches. The outer wheels on which the table runs are equipped with roller bearings.

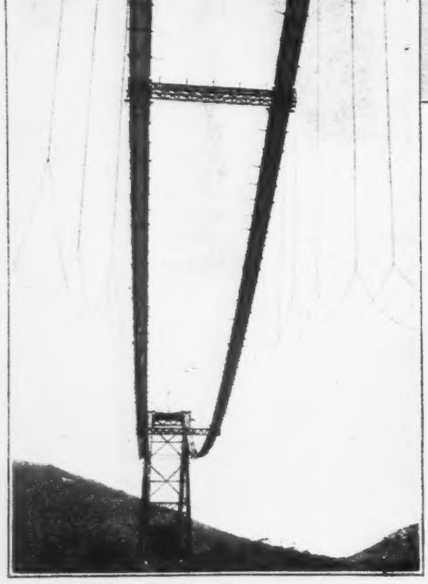
The table may be installed at any convenient point at small expense, it is claimed, and can be moved readily.

Workmen Walk across Great Hudson Bridge

CONSTRUCTION of America's greatest suspension bridge—The Bear Mountain bridge across the Hudson—has progressed to a point where workmen actually have walked from shore to shore across two temporary suspension bridges.

This great project will be the first bridge across the river between Poughkeepsie and New York City. Its total length will be 2252 feet, including approaches.

Building a span above the Hudson



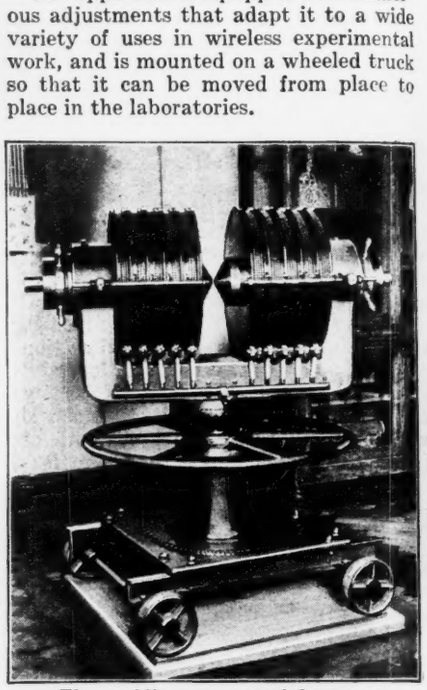
View of the two temporary spans, showing the great size of the project

Most Powerful Magnet Used for Experimental Work

THE most powerful electric magnet in the world, used in connection with wireless research, has been installed in the laboratories of the University of Strasbourg, in Alsace. It was constructed upon the calculations of M. Weiss.

When the magnet is in operation, the strongest man would be unable to pass a steel butcher knife through the air between its two poles.

The apparatus is equipped with numerous adjustments that adapt it to a wide variety of uses in wireless experimental work, and is mounted on a wheeled truck so that it can be moved from place to place in the laboratories.



The world's most powerful magnet

Hearing the Printed Word

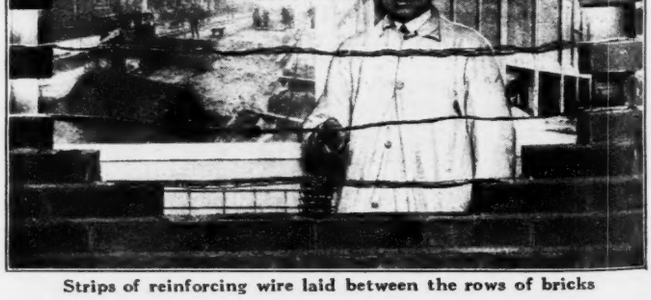
BASED on a principle similar to that employed in the telephone, a new device for making the printed word audible has been invented in Germany. The secret is said to lie in modifying printer's ink to make it conductive of electricity in varying degrees.

On strips of paper, symbols that are very similar to the Morse dot-and-dash code are printed in this ink. These strips then are used in an electrical apparatus to make and break electric contacts so as to sound a bell or buzzer.

Brick Walls Reinforced by Layers of Wire

TO PREVENT brick houses from "cracking" and to give buildings added solidity, a new system of reinforcing has been introduced. This consists of laying a wire between every second layer of bricks.

As each layer is completed, wire is stretched along the top, and on this is spread the mortar for the next row.



Strips of reinforcing wire laid between the rows of bricks

Valuable Documents Copied on Film Negatives

A MACHINE for copying letters and other documents without subjecting them to the scrutiny of outsiders has been developed to give instantaneous photographic records of any letter-size papers, identifying them so as to make them admissible as legal evidence.

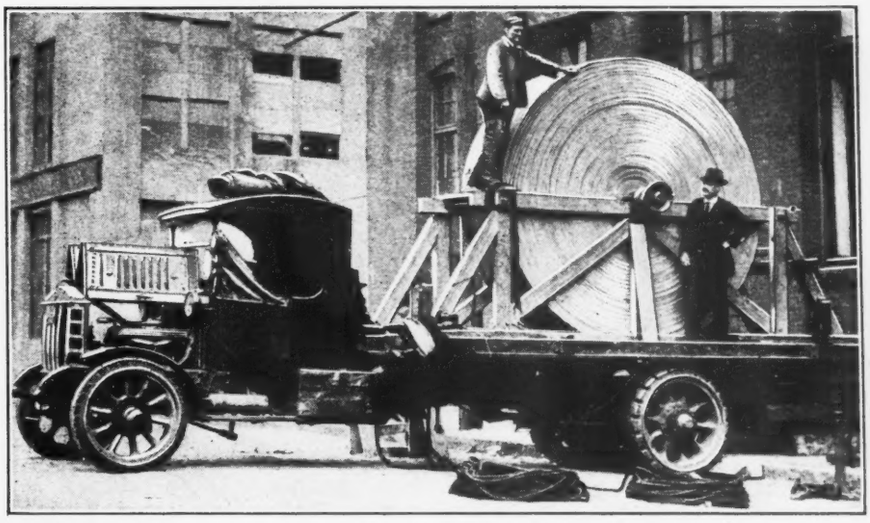
A miniature film negative of motion-picture size is used. Documents are placed under a glass illuminated by special reflectors. Pressing a button starts a motor that moves a section of film before the lens, exposes it and moves it on to make way for another picture. Any number of pictures thus may be made of

Photographing papers with film machine

any document. The miniature negatives then are developed and enlarged.

Each document is positively identified by means of a special arrangement at the top of the glass that holds the paper being copied. This consists of three bands of fragmentary geometrical designs and a serial number, the bands and serial number automatically changing with the changing of documents.

The bands move in opposite directions at different rates so that each document copied has photographed with it a record of the serial number and a different design, making counterfeiting impossible.



World's Largest Belt Weighs Seven Tons

THE largest belt in the world was made recently for a concern in New Jersey. The belt is 1550 feet long, 36 inches wide, weighs seven tons, and cost $1000 a ton.

It took 12 workmen more than three hours to wind it on a reel more than nine feet in diameter. The illustration shows the belt wound on the reel.

A Push Releases Automatic Door Check

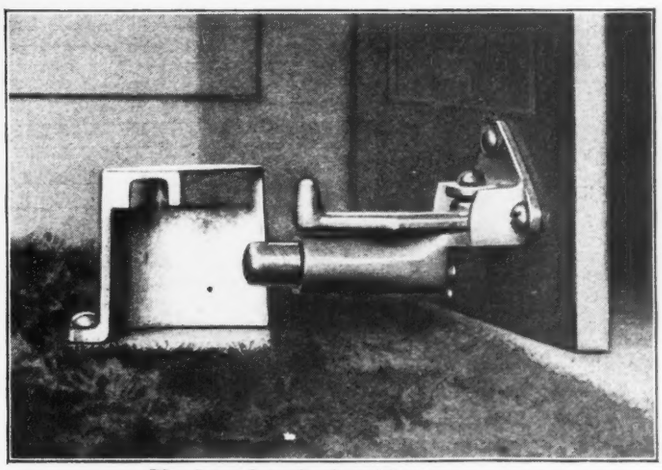
A NEW automatic door check is so designed that one push on an open door fastens it and a second push in the same direction releases it.

At the base of the door is fastened a hook connected with a spring plunger or bolt, which extends slightly in front of the hook.

A base plate screwed into the floor contains a slot to catch the hook and hold the door open.

When it is desired to close the door, a second push compresses the plunger and allows the hook to move into a channel of the base plate. This disengages the hook so that the door may be closed again.

While designed primarily for use in railroad cars, the device is adaptable also to garages.



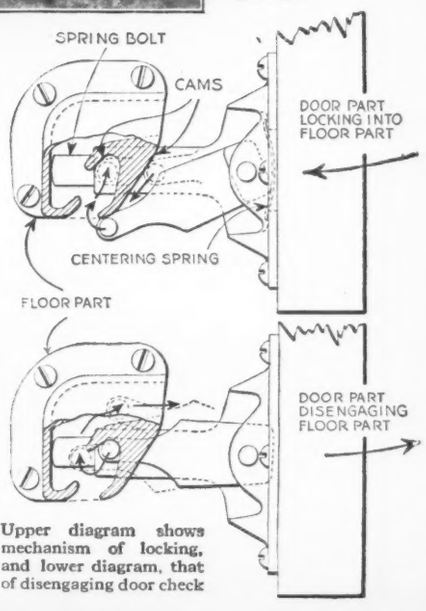
The floor plate, hook and bolt

Road-Finishing Machine Driven by Two Men

A HAND-OPERATED road-tamping and -finishing machine, said to finish concrete roads as satisfactorily as motor-driven machines, has been developed for use by contractors. The machine moves on two tracks that constitute the form for the concrete. A shaft extending across the top of the machine is turned by two men, one on each side of the road.

Through the action of a cam, the tamper is given both vertical and lateral motion, insuring a perfect crown. Two strike-offs, a tamper, and wood-finishing belt, passing over the plastic mass leave the surfacing smooth and with the desired crown to the road.

The machine runs on tracks that serve as the form



Upper diagram shows mechanism of locking, and lower diagram, that of disengaging door check

Shall We Add a Thirteenth Month?

Radical New Calendar Advocated to Simplify Calculations

By Truman Stevens

ON JANUARY 1, 1928, it is possible that the world may begin to live by an entirely new calendar, a calendar in which a year will consist of 13 equal months of four weeks each, and in which the same date of every month always will fall on the same day of the week.

Such a revolutionary revision not only is being considered by a special committee of the League of Nations, but also has been urged in recent resolutions passed by the American Meteorological Society at Washington, D. C., where it was actively supported by Dr. C. F. Marvin, chief of the United States Weather Bureau. He declares it would greatly simplify the collection and study of weather data.

The year 1928 is advocated as the most favorable time to start the new calendar, according to Doctor Marvin, since that year begins on Sunday. Consequently the first day of each of the 13 months would fall on Sunday.

REFORM of the calendar is not such a new thing as it may seem. It is as old as the history of man. For centuries efforts have been made to improve the calendar so that it would coincide with the astronomical year—that is, the time required by the earth to complete its journey about the sun—and so afford complete unity between man's and nature's reckoning of time.

The ancients had many calendars, all of which were inaccurate and no two of which were alike. To correct the resulting confusion, Julius Caesar initiated an important reform—the Julian calendar. This gave the civil year exactly 365 days, or nearly a quarter of a day less than the astronomical year, which is 365 days, 5 hours, 48 minutes, and 45.9 seconds. This discrepancy was corrected every four years by adding an extra day to February, creating the bissextile or leap year.

But over an extended period even the Julian calendar accumulated discrepancies, which in the time of Pope Gregory had reached the extent of 10 days. Radical corrections resulted in the Gregorian calendar which, so far as length of the calendar year is concerned, probably is as nearly perfect as possible. Yet while it is the standard calendar of today, the result of its method of dividing the year into months of various lengths is that no two consecutive months or years begin with the same day of the week. For this reason a calendar dividing the year into equal, corresponding parts has been sought.

A solution in the form of the 13-month calendar was worked out not long ago by a French engineer. It is called the "Delaporte calendar," after the name of the inventor. For the purpose of equal division, Delaporte would take a year of 364 days, the extra 365th day becoming New Year's Day. Then he proposes to divide the year into 13 months instead of 12, each month to be composed of four seven-day weeks, or 28 days. An extra day would be added in leap year.

Since 13 months cannot be divided exactly into four equal parts, Delaporte would divide the 364-day year into four seasons, each containing 13 weeks. The first day of the year would be fixed at the winter solstice—the shortest day, corresponding to December 22 of our present calendar.

Every month in every season would contain the same number of workdays, the same number of days of rest. It is a modification of this plan that is being advocated for 1928.

EXPONENTS of the plan say it would be of great benefit to labor. All calculations of income and expenses would be unified. As it is now, the laborer who is paid a fixed wage a month works only 24 days in February while in other months he works 25 or 26. Under the new calendar the working man would receive the same monthly wage for the same amount of work. The annual wages would not be smaller, because the men would be paid for 13 months instead of 12 and the aggregate would be the same.

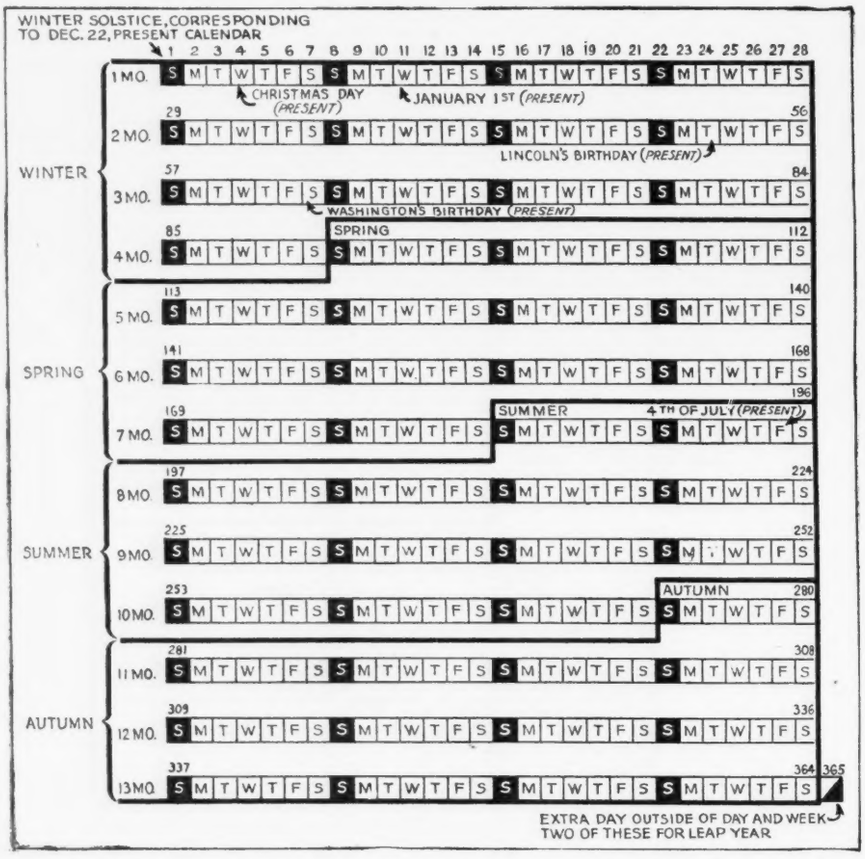
From the point of view of religious observance the new calendar would offer many advantages. The movable feasts, Easter, Ascension, Pentecost, always would fall on fixed days, and the immovable holidays always would fall on the same day of the week.

For example, assuming that the first day of the year (corresponding to the present December 22) would be Sunday, our Fourth of July would fall every year on Friday, the twenty-seventh day of the seventh month. The present Christmas Day would fall on Wednesday, the fourth day of the first month, and the present New Year's Day on Wednesday, the eleventh day of the first month.

The new calendar undoubtedly offers many advantages—an exact solution of a world-old problem. But will the world ever accede to the great change that would be necessary to conform to it?

The committee of the League of Nations that now is considering the calendar reform, includes representatives of the world's great religious, scientific, and industrial organizations.

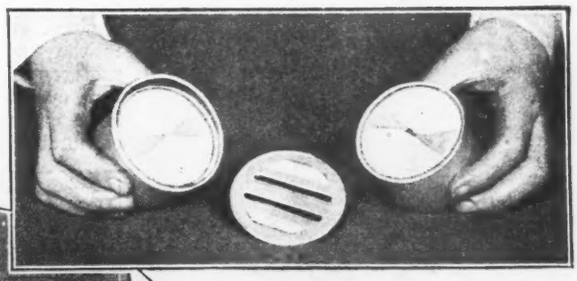
America's representative on the committee is Willis H. Booth, of New York, president of the International Chamber of Commerce. The conferences are expected to result in definite recommendations to the League. Action by the League would be followed by legislative proposals to the various governments.



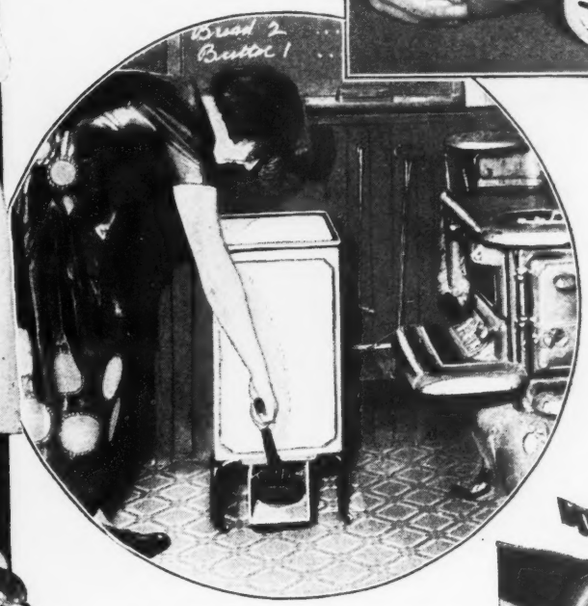
The Delaporte calendar, showing how the year, beginning at the winter solstice, would be divided into 13 equal months of four weeks each, with an extra day for New Year. The year also is divided into four equal seasons of 13 weeks. Notice how the same date of every month falls on the same day of the week. The positions of present holidays are indicated

Applied Science in the Household

A vacuum cleaner with a suction handle, as well as a suction base, can be used for cleaning places otherwise inaccessible, such as bookcases and chests. It has a self-adjusting nozzle



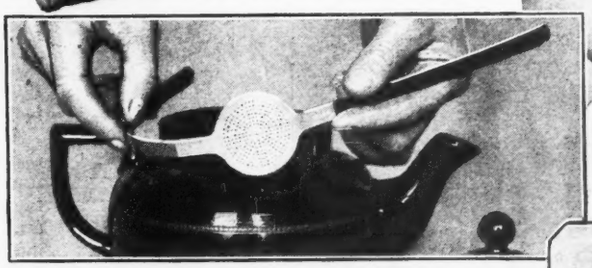
An aluminum box made in two sections with a removable slotted plate in the center forms an effective egg-beater. The egg is broken into one section, the loose plate is laid in position, and the other section of the box attached. Shaking the box beats the egg



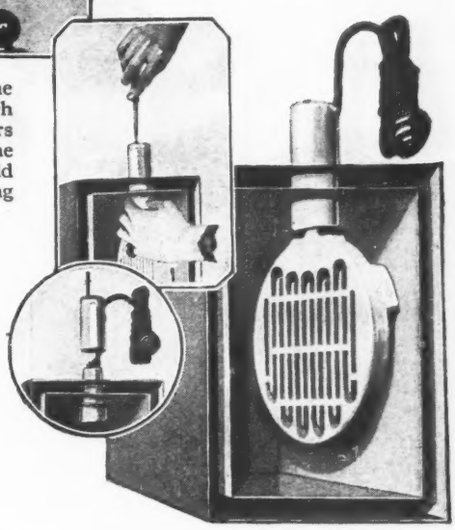
This neat kitchen coalbox has at its base a movable chute that drops out a small quantity of coal where it may be reached easily with a shovel

This serviceable jar-opener consists of a strap of spring steel, notched at the side to engage a lever handle, and with lugs in the center to grip the cover tightly and so unscrew it

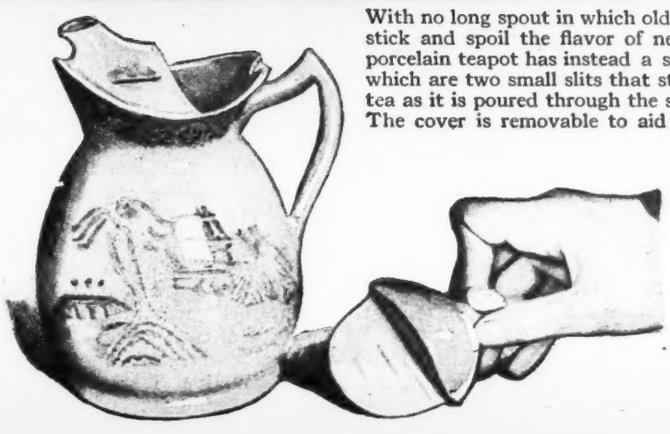
The vegetable slicer below consists of a frame into which may be inserted a variety of cutting plates by opening one side of the frame



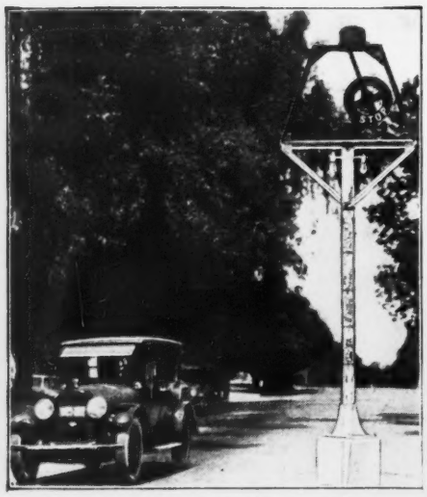
This invisible tea-strainer is held firmly inside the pot by a spring band of stainless steel to which it is attached. In the pot the strainer covers the base of the spout, and is held by the spring



Any oven may be converted into an electric oven by this newly designed heater, which is quickly attached to the oven wall by a single screw, and which plugs into an ordinary electric socket. The heater may be used also for fireless cookers, clothes-driers, bed-warmers, and water-heaters



With no long spout in which old leaves may stick and spoil the flavor of new tea, this porcelain teapot has instead a special lid in which are two small slits that strain all the tea as it is poured through the small spout. The cover is removable to aid in washing



Swinging Pendulum Warns at Grade Crossing

FRESNO, Calif., has augmented the usual railway grade-crossing sign by the installation of an electric warning post in the center of the street.

A pendulum hung from a frame at the top of the post, swings continuously, calling attention to motorists of the presence of railway tracks.

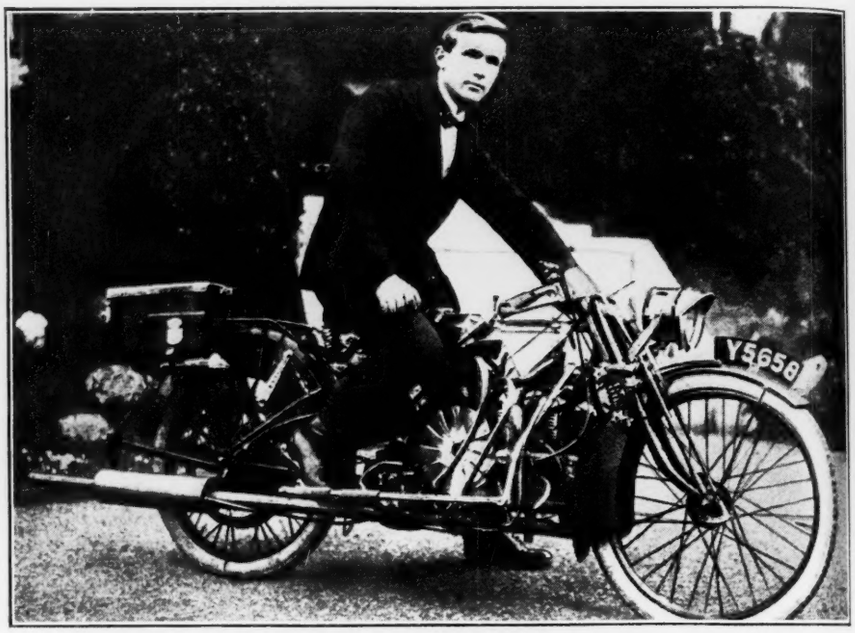
On the swinging pendulum is a "Stop" sign for daytime warning, and a red light that flashes a danger signal at night.

The supporting column is well lighted to prevent the possibility of a motor-car's colliding with it.

Odd Motorcycle Is Driven by Twin Engines

A SIX-CYLINDER motorcycle consisting of two separate three-cylinder engines, one on each side of the frame, is the unusual invention of a British motorcycle enthusiast. The engines are four cycle and together are rated at 16 horsepower. Each have magneto and carburetor, and are cooled by vertical fans.

Mechanical lubrication with sight feed, and chain transmission with three speeds are used. There are shock absorbers on the front forks, two gasoline tanks, speedometer, clock, a gradient meter and gasoline gage. A small tank under the seat carries reserve fuel. Brakes are installed on front and rear wheels.

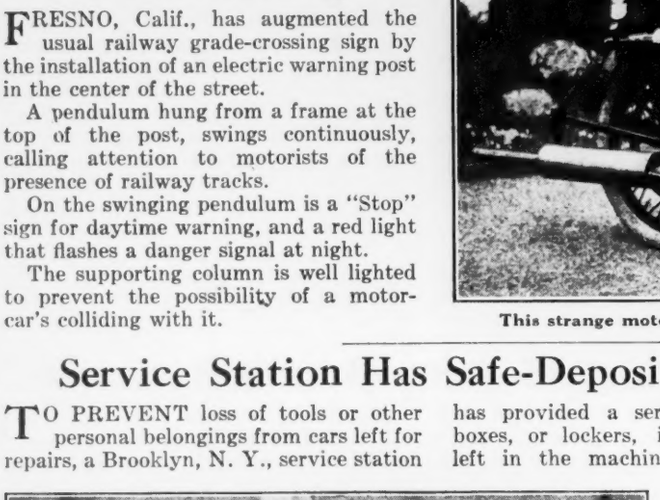


This strange motorcycle is driven by two three-cylinder engines, one on each side

Service Station Has Safe-Deposit Boxes

TO PREVENT loss of tools or other personal belongings from cars left for repairs, a Brooklyn, N. Y., service station has provided a series of large metal boxes, or lockers, into which articles left in the machine are placed. The owner is given the key and an identification check.

The lockers are stored in racks in a special vault. The seat cushions of the cars likewise are checked and stored on shelves above the lockers to prevent any possibility of their becoming soiled and stained by grease and oil while mechanics are working on the automobile.



Articles from the car are stored in safe-deposit boxes as shown

The Origin of Paved Roads

OUR modern dustless concrete auto roads may be said to have originated in a dusty limestone highway of England. Just 100 years ago, Joseph Aspdin, a mason of Leeds, England, discovered that if the dust of limestone roads was mixed with clay and burned at a high temperature, the resulting mass when ground would produce a material that hardened when mixed with water.

This hard, stonelike substance looked like building stone quarried at Portland, England, so he called it Portland cement. Because he mixed brains with his mortar, we ride over concrete roads today.

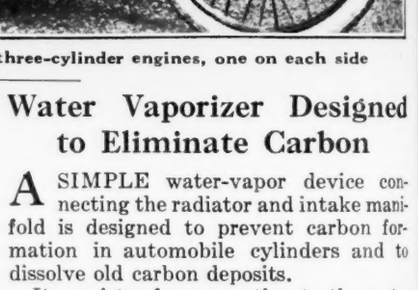
Water Vaporizer Designed to Eliminate Carbon

A SIMPLE water-vapor device connecting the radiator and intake manifold is designed to prevent carbon formation in automobile cylinders and to dissolve old carbon deposits.

It consists of a connection to the water discharge pipe near the radiator, an automatic valve installed in the gasoline intake manifold, above the butterfly valve, and a length of small copper tubing joining the two fittings.

Through four small holes in the body of the automatic valve, air is mixed with the water in order to vaporize it. The water is taken from the circulating system so that no extra tank is necessary, the amount being regulated automatically by the speed of the engine. It is shut off automatically when the engine stops.

The distinctive feature about the device is its simplicity.



Arrows indicate radiator-manifold connection

Worth of Used Cars Tested in Laboratory

CHICAGO motorists, at least, now enjoy the prospect of being able to buy used cars with a reliable certificate of full value for their money.

This has been made possible by the establishment of a huge new testing laboratory in Chicago, under control of the Automobile Trade Association, comprising the used-car dealers of Chicago in its membership. The laboratory is prepared to test about 100 cars a day, and to give every car a combing over that will leave absolutely nothing uncovered in the way of defect that may harass the purchaser.

Testing used cars in the Chicago laboratory to assure protection to the purchasers

The first step in the tests is a sort of "registration" of the make of the car, type, and model, and the specifications a car of its age and type should meet.

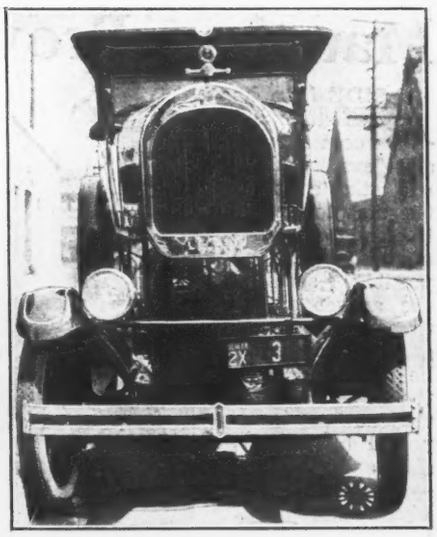
Then the car falls into the hands of expert electricians. First, the battery and starting motor are tested while the starting motor is turning the engine. The performances of the battery and motor are compared with standards. With the engine running, the electricians then check the generator output as well as the cut-in and cut-out points of the regulator. An unduly high or low charging rate is detected.

SPARK plugs and ignition are tested by means of a grounding gap. This test tells also whether the plugs are set properly and whether they are firing as they should. The engine then is stopped while a careful examination is made of the breaker points and the ignition unit. If the car "passes," its future owner may be sure the ignition system will function properly.

In practice, a test of all electrical equipment is completed in less than 15 minutes. The car then moves along to the Wasson horsepower-testing stands. On these stands the automobile runs under its own power with its rear wheels turning on friction drums. A pony brake, operating on the drums, determines horsepower delivered at different speeds and the twisting effort, or torque.

Meanwhile examinations of fuel consumption and piston leakage are made. Also a sample of the cylinder oil is drawn from the engine base and the amount of water, dilution, and other chemical factors are determined accurately by chemical tests. The final step is a careful examination for defects in the chassis, springs, or mechanical parts. Should any of the parts have heated under the loads, this examination reveals it.

If the car stands up under all the probing, the laboratory issues its O.K. Thereafter any buyer may be sure that when he takes the car on the open road, it is likely to give satisfactory service.



Novel Car on Stilts Offers a Bird's-Eye View

TO ATTAIN the utmost in novelty motoring and incidentally a bird's-eye view of the scenery, a Los Angeles man put his car on stilts by raising the body several feet above the chassis and extending the operating levers the necessary distance. Now he is able literally to look down on every one.

While the appearance of the car is grotesque, it is operated the same as any other automobile. Its chief drawback, of course, is the long climb from the ground.

One Man Runs Combined Tractor and Grader

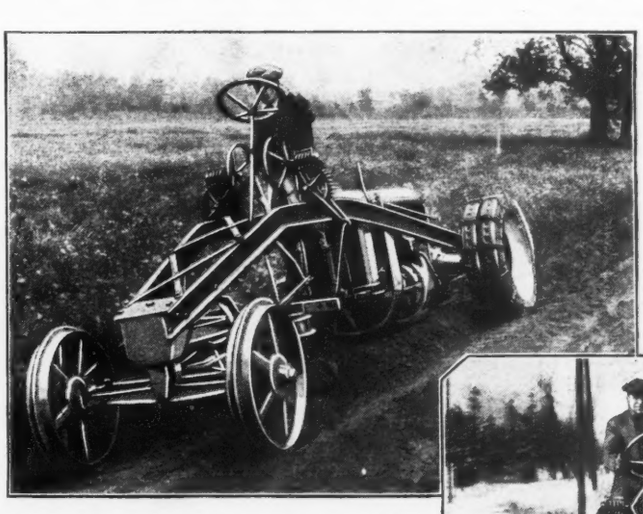
OPERATED by one man, a new combined grader and Fordson tractor now coming into use on hundreds of roads throughout the country, is said to cut the cost of roadmaking and maintenance enormously. No teams or extra drivers are required, and the machine works rapidly on the roughest surfaces. In winter it functions equally well as a snow remover.

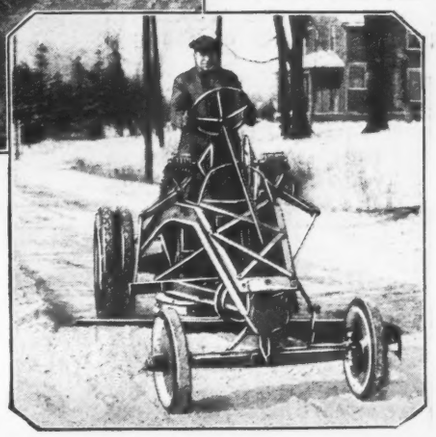
The grader blade can be raised quickly and lowered or swung to either side, at any angle. The tractor clutch and gears are manipulated from the operator's platform by hand and foot levers, giving the ease of automobile control.

The grader is constructed largely of electric steel castings and heavy steel sections.

The grader can be assembled, it is claimed, within an hour. No holes need be drilled. Disassembly is said to be at least as easy, permitting the tractor to be used readily for other purposes when needed for them.

Two quarts of oil and 15 gallons of gasoline, it is claimed, will operate the grader steadily through an eight-hour day.





The combination tractor serves as a road-grader (left) or a snow-remover (below), according to the time of year

Maughan Proves U. S. Airway Possibilities

ASIDE from its scientific and commercial, significance — demonstrating as it did the marvelous capabilities of the modern airplane, and possibly speeding the arrival of the time when passengers and freight will be carried through the air as readily as they now are transported by railway, ship, and motor-car —the recent feat of Lieut. Russell L. Maughan, U.S.A., in flying from New York to San Francisco between daylight and dark, stands forth as one of the most daring exploits of all time.

Lieutenant Maughan and his plane at the end of his transcontinental flight

No glory is taken from Maughan's achievement by the fact that more than a year ago Lieuts. J. A. Macready and O. G. Kelly accomplished an Atlantic-to-Pacific flight without descending from the air—still the world's record non-stop flight. On the contrary, the conditions under which the flights were accomplished were so decidedly different that Maughan's feat becomes all the more remarkable.

Maughan's airplane was a Curtiss one-seat pursuit plane, designed to remain in the air for only about three hours. It was exactly like 25 other planes now being constructed for the army air service. No change was made in body or mechanism in preparation for the coast-to-coast flight, beyond providing additional gasoline storage space.

The plane used by Macready and Kelly was the army transport type—a large, comparatively slow craft. It was balanced and operated by automatic devices, making it unnecessary for the pilots to do more than steer it.

Maughan, besides being alone, was forced to exercise constant vigilance. And so for the 21 hours, 47 minutes, and 45 seconds that elapsed between his take-off at Mitchel Field, N. Y., and the time of his landing in San Francisco, Maughan was constantly on the job.

MORE than that, he was sick for virtually every second of the 18 hours, 30 minutes, and 45 seconds that made up his actual flying time. Speeding through the rarefied upper atmosphere at an average rate of 154 miles an hour for 2850 miles, Maughan was afflicted with a violent nausea, an enervating, discouraging illness that aviators describe as being akin to seasickness. The only respite Maughan had from his illness was during the three hours and 17 minutes that he spent on the ground while his gasoline was being replenished and minor repairs were being made on his machine. Despite this, though, he persevered, bettering the time of Macready and Kelly by five hours and 36 minutes, winning all the laurels that rightfully belong to the first man to fly across the American continent alone and unaided in a single day.

Maughan's flight, however, was no mere feat of physical endurance. It was a test arranged by the army air service of the mobility of this country's air fleet. And from a military standpoint, Maughan's personal glory is secondary to the proof he gave that in time of necessity the air forces of the United States can be mobilized in any section within a day.

And while army officers were dwelling on this thought, the Post-Office Department inaugurated its coast-to-coast air mail service that takes letters from New York to San Francisco in 34 hours and back in 32.

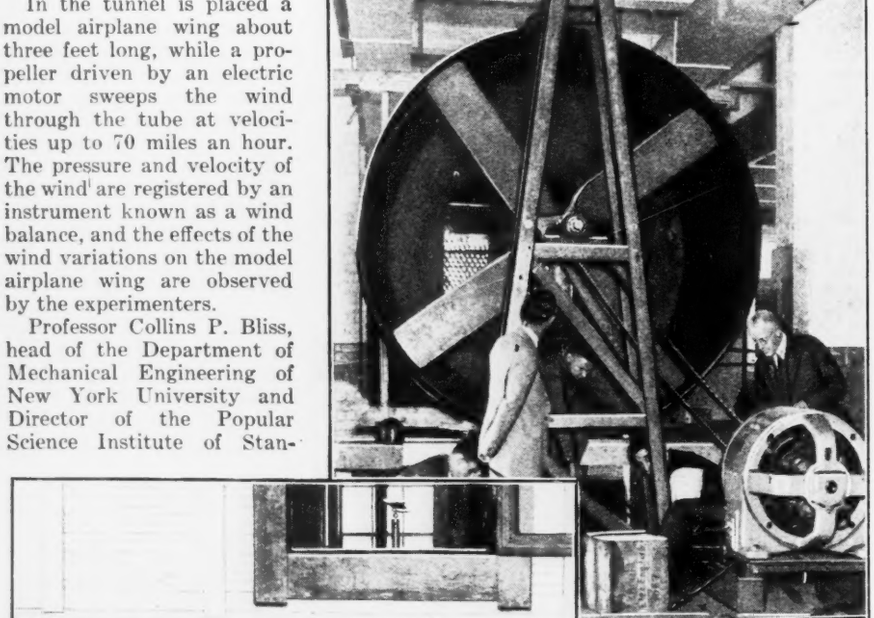
These two epochal events, occurring within a few days of each other, surely point the way to the tremendous possibilities of aviation in the next few years.

Wind Tunnel Used in School of Aviation

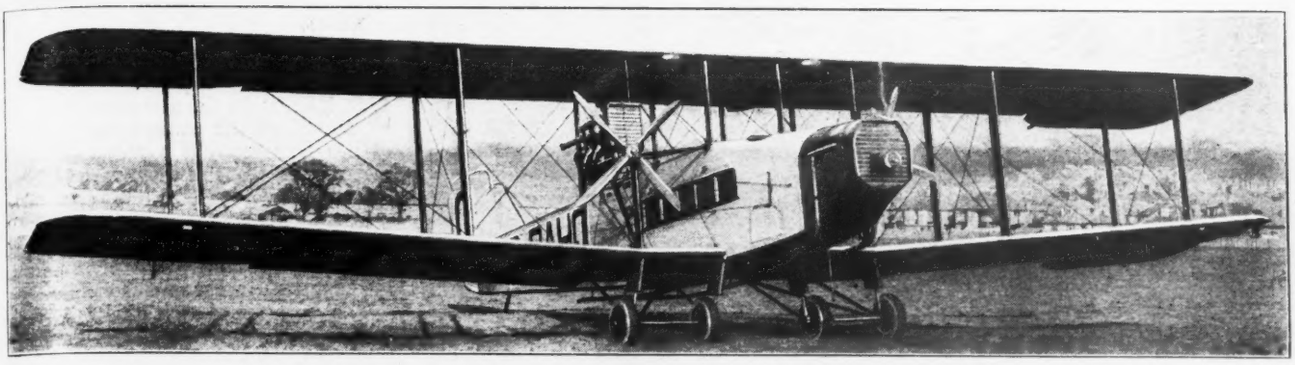
FOR scientific experiment in the design and construction of airplanes, and for the study of wind pressure and velocity in relation to the lift and resistance of airplane wings, a wind tunnel recently has been added to the mechanical equipment of the aerodynamics department of New York University.

In the tunnel is placed a model airplane wing about three feet long, while a propeller driven by an electric motor sweeps the wind through the tube at velocities up to 70 miles an hour. The pressure and velocity of the wind are registered by an instrument known as a wind balance, and the effects of the wind variations on the model airplane wing are observed by the experimenters.

Professor Collins P. Bliss, head of the Department of Mechanical Engineering of New York University and Director of the Popular Science Institute of Standards, and Prof. Alexander Klemin, are in charge of the work being conducted with the new machine, which is the first of its kind. It is expected to aid greatly in giving students of the university a grasp of the fundamental principles on which the mechanics of aviation are based.



Above: The wind tunnel at New York University. Professor Collins P. Bliss, head of the Department of Mechanical Engineering, and Director of the Popular Science Institute of Standards, is seen at the right. Left: The instrument that registers velocity and pressure in the tunnel



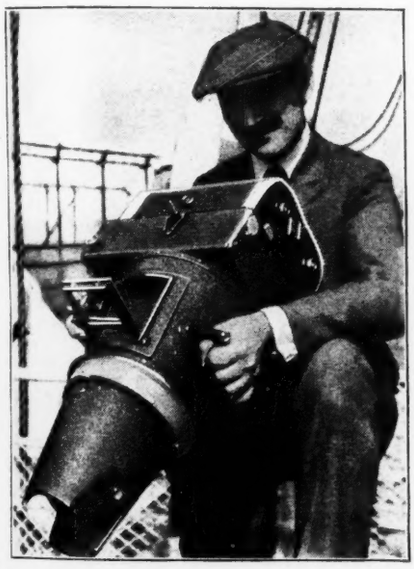
Sturdy Triple-Engine Planes to Fly across Kongo Jungles

AIRPLANES are about to fly over the jungles in the Belgian Kongo, Africa, cutting a 45-day land journey to a two-day jaunt through the air.

For three years the Belgian government has been conducting tests to perfect the new type of plane shown above, capable of making the rigorous 1200-mile journey that virtually lies along the equator. The extreme climatic conditions cause a severe strain on the structure of planes in this area and landing-fields along the route are practically nonexistent.

The new type plane therefore will be equipped with three engines, a 350-horsepower Rolls-Royce in the nose of the fuselage, and two 230-horsepower engines on the wings. Should any one of the engines fail, the plane still can hold the air and reach its destination. The front engine alone is capable of flying the ship if it is not loaded with its full complement of freight.

The wing span of the machine is 75 feet; the length of plane, 60 feet, and the height 17 feet. Accommodations for 10 passengers and 1000 pounds of luggage will be provided and the flying speed will be more than 100 miles an hour.



This Camera Takes Photos at Record Height

A LONG-DISTANCE aerial camera of the type with which Lieut. John A. Macready, test pilot, and A. W. Stevens, aerial photographer, recently took pictures of Dayton, Ohio, from a height of nearly six miles, will be part of the equipment of an expedition scheduled to go 3000 miles up the Amazon River. With it the first aerial photographs of the mighty river will be made.

In photographing Dayton, the giant camera registered clearly objects on the ground invisible to the airmen. Captain Stevens is shown above with the camera.

Smoke Screen Hides New York Skyscrapers

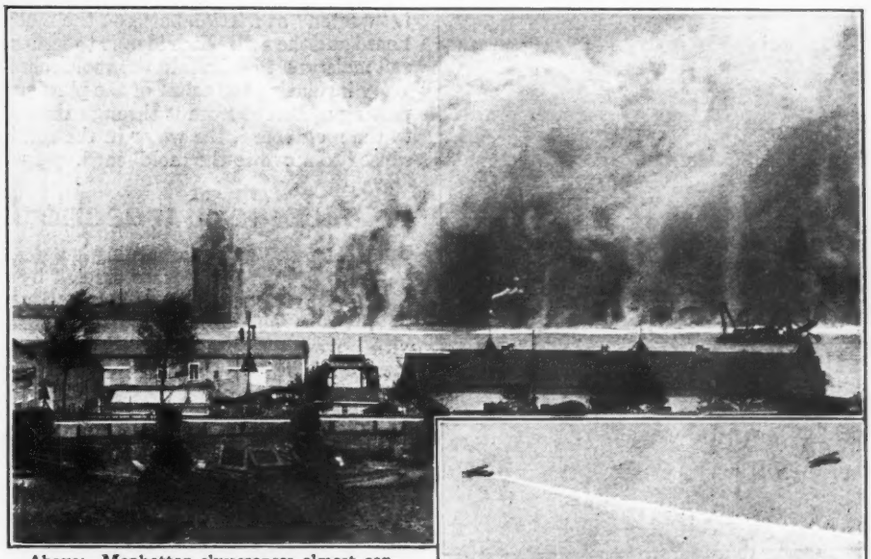
UNCLE SAM'S army fliers recently gave New-Yorkers a thrill when they blotted out the lower end of Manhattan by dropping a smoke screen over that part of the city from airplanes equipped with special chemical apparatus.

The aerial demonstration was conducted under the direction of the Chemical Warfare Service and the Army Air Service to gage the possibility of screening America's largest city from the attacks of an enemy.

The smoke screen proved an effective barrier to vision, but was not impenetrable to "enemy airplanes," which flew through it easily.

Varying in color from white to greenish white, the screen was laid down by two tanks under the body of each plane. The tanks contained titanium tetrachloride and carbon dioxide, and both discharged their contents through a common outlet at the tail of the machine.

Air contact vaporized the chemical combination, which dropped rapidly. In the test the smoke fell until it struck the water, clung there a moment, then rolled upward, where it gradually thickened.



Above: Manhattan skyscrapers almost concealed by the smoke screen dropped by airmen. At the right, an army smoke plane

The Mirage—A New Danger to Aviators

A NEW peril of long-distance flight was revealed in a recent statement by Maj. Frederick L. Martin, who was commander of the round-the-world flight of United States Army planes, and whose machine crashed against a mountain peak in the Aleutian Islands. He ascribed the mishap to a mirage that changed the apparent face of his surroundings.

A mirage is a picture in the air caused when light rays carrying an image are bent by variations in the atmosphere's density. Such distortion may entirely upset a flier's judgment of distance.

Twenty-Foot Trench Forms a Natural Silo

AN ENTERPRISING farmer at Tucson, Ariz., put into use an unusual silo that might be duplicated by other farmers. He excavated a trench about 20 feet wide and deep and 300 feet long. The silage was packed to the earth's surface and covered with two feet of clay—a method that is said to keep the silage in as good condition as with the most elaborate modern silos.

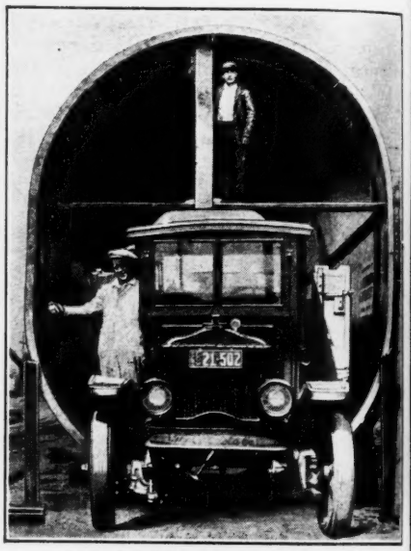
Motor-Truck Can Drive through Huge Stack

SO HUGE are the new smokestacks installed on the transpacific liner, *City of Los Angeles*, that a motor-truck can drive through one of them with plenty of room to spare.

These huge funnels are part of $1,000,000 worth of new equipment for the famous steamer that plies between Los Angeles Harbor and Honolulu.

The diameter of each stack is 17 feet 3 inches; the height, 37 feet, and the weight is 30 tons.

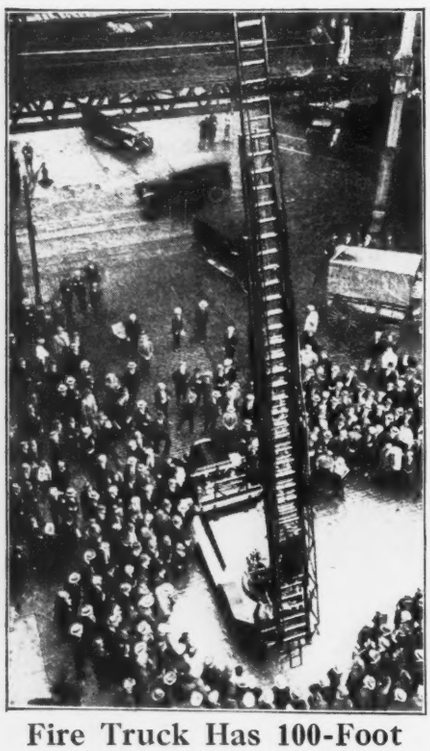
The illustration shows a truck driving through one of the stacks as it lies on its side at a Los Angeles shipbuilding plant, waiting to be put in place.



A truck driving through the stack

Wigs Made of Glass Hair

FINE threads of spun glass, such as is used for sparkling tinsel on Christmas trees, are being made into wigs for women by a newly discovered process, which may set a new style.



Fire Truck Has 100-Foot Extension Ladder

NEW YORK CITY'S newest fire-fighting equipment consists of a 100-foot extension ladder that folds up on top of the motor-truck that carries it. Mechanism at the base makes it possible to turn this huge ladder in any desired position and to extend it upward to a height of several stories of a building with extraordinary rapidity.

Electricity Employed to Make Plowing Easier

AN INGENIOUS electrical method for making plowing easier has been invented in England.

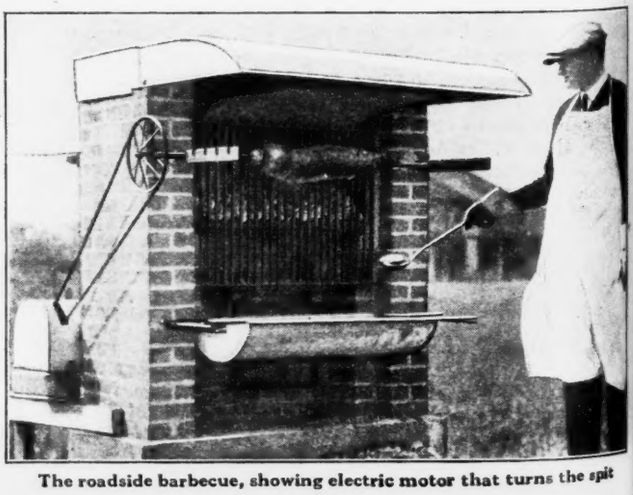
A large part of the work done in plowing is "wasted" as friction between the moldboard and the soil. The idea is to use the soil moisture to lubricate the moldboard.

By insulating the colter of the plow and passing a current from it through the soil to the moldboard, the water in the soil is caused to move to the moldboard.

Roadside Barbecue Feeds Hungry Motorists

THE latest idea in barbecuing is a roadside fireplace and grate erected by a Cincinnati man along the Lincoln Highway, where he supplies motor tourists with fresh hot sandwiches or roasts right off the fire.

The meat is placed before the fire on a steel spit that is rotated by a small electric motor connected with it by a belt and pulley. A trough below catches the meat juices. All the operator has to do is to start the motor and dip up the juices from the trough to baste the meat. Gas or charcoal is the fuel used for roasting. The originator of the idea is R. W. Wiggins, who is shown in the picture, and it is said that motorists are giving him every encouragement.

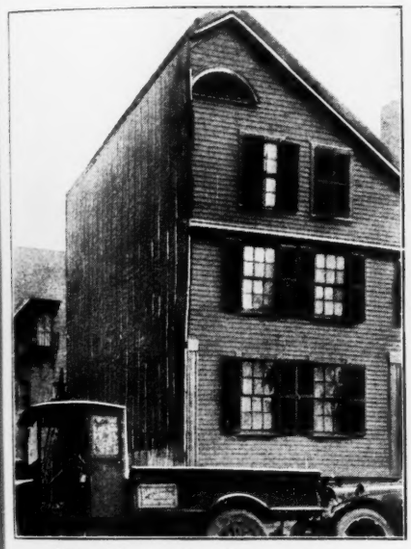


The roadside barbecue, showing electric motor that turns the spit

House Cut in Half to Make Room for Building

WHEN a power company in Manchester, N. H., recently desired to put up a new repair shop, there stood in the way a house, one half of which occupied part of the proposed building-site. The other half of the residence stood on an adjoining lot.

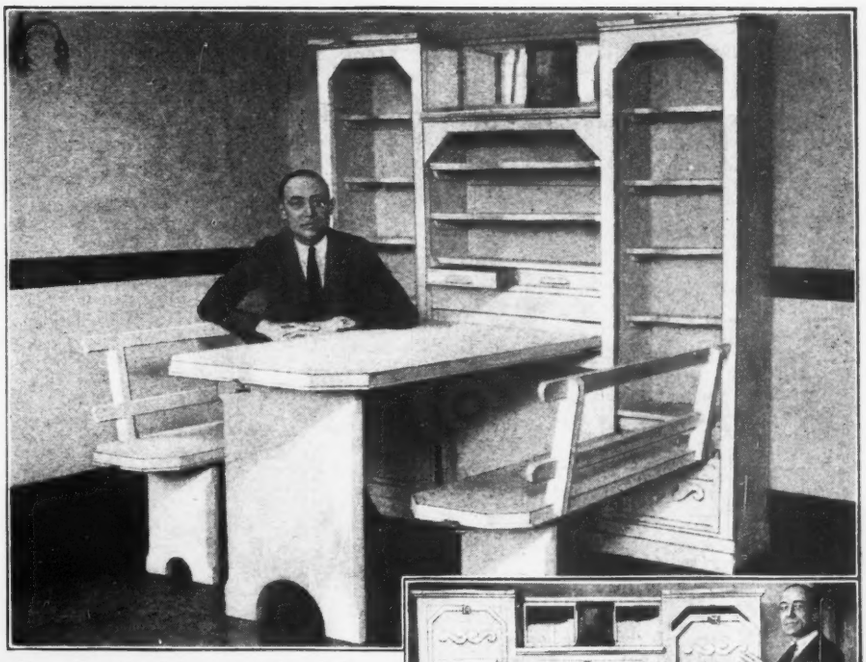
When certain conditions made it impossible to move the entire house, the contractors decided to cut the dwelling in half and remove the half that occupied the building-site. After making a straight cut from roof to basement, they walled up the exposed side, as shown in the illustration.

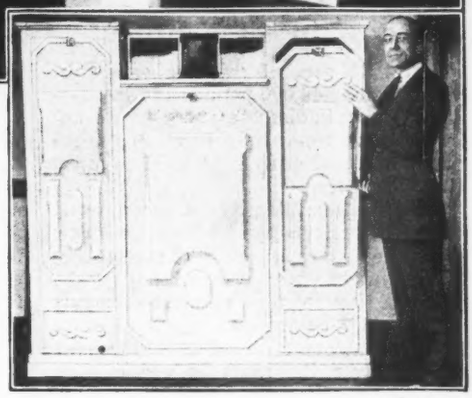


View of house after the operation

Electric Sign a Block Long

THE world's largest electrical advertising sign now flashes out the merits of a brand of ginger ale from a building in Times Square, New York City. The sign extends for an entire city block and is 58 feet tall, almost equal to the height of a six-story building.





The collapsible dining-room when it is unfolded (above) and folded (at the right)

Folding Dining-Room Economizes Space

AN UNUSUAL collapsible dining-room that folds up to the size of a bookcase and that can be moved from place to place on casters, recently was patented by an architect of Washington, D. C.

When folded, it resembles in appearance an old-fashioned folding bedstead. When it is to be opened for a meal, the central panel swings downward to rest on a hinged support. Two side panels also swing downward and unfold to form two benches, each of which will seat two persons.

The opening of the panels exposes a dozen shelves for dishes and the table linen; also two drawers for silver. The table may be used for an ironing-board if desired. It is claimed that this novel dining-room can be handled by a child.

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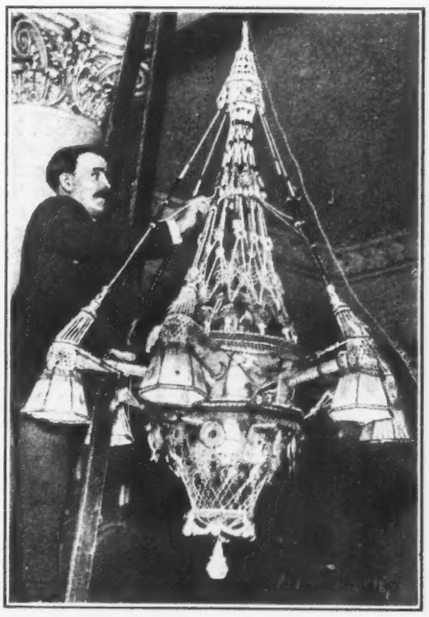
Ornamental Lamp of Cord Made by a Sailor



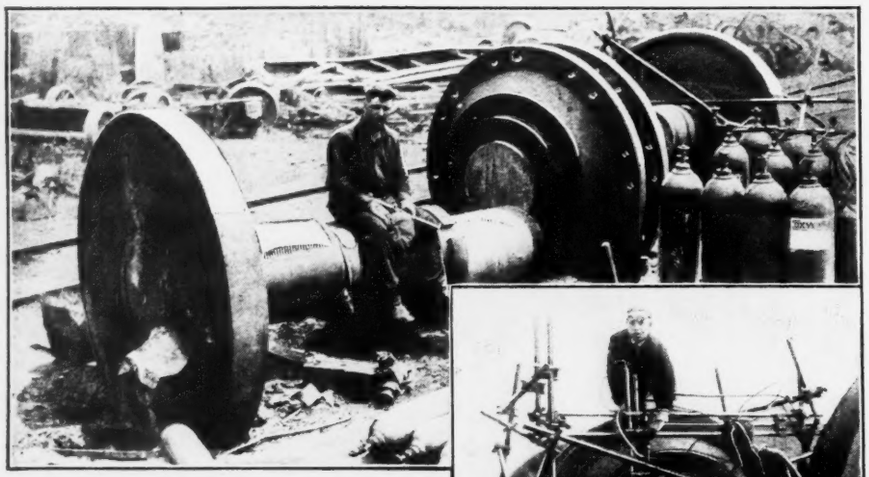
THE first lamp made entirely of cord recently was exhibited in a New York hotel. This unique lighting fixture took a year of labor by a Spanish sailor, Juan Rios Rivera. It was said to have been made for a beautiful girl Rivera fell in love with after he had rescued her from death by drowning.

Complete Playhouse Has Electric Lights

The small hostess "at home" to her friends in the playhouse

ONE of the latest attractions at Vancouver, B. C., is a child's playhouse that is a perfect model of a real "grown-up" house, including real electric lights, furniture, kitchen and dining-room equipment, porch, lawn, shrubbery, and all the rest.

The miniature home was built by Capt. W. Simpson for his small daughter. The young housewife is shown officiating at a formal "at home" for her little friends.



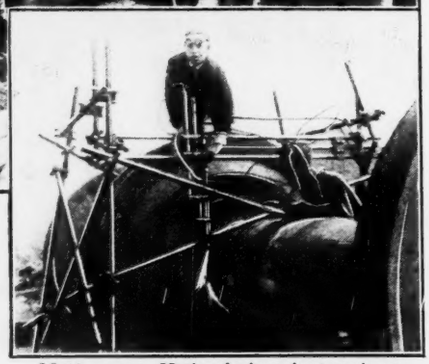
The steel generator shaft, 27 inches in diameter, after the cuts had been completed

Torch Cuts through Huge Shaft in 10 Minutes

A HUGE generator shaft of solid steel weighing 40,000 pounds and measuring 27 inches in diameter recently was cut through five times by a torch in the remarkable speed of from 10 to 17 minutes for each cutting.

Owing to the intense heat encountered in such heavy cutting and the consequent punishment to the operator in attempting to manipulate a torch continuously for the length of time required to complete a cut, an ingenious device was rigged to carry the torch at the required uniform speed up and over the shaft as the cutting progressed.

The device consisted of a pipe framework erected over the horizontal shaft and supporting two 1½-inch parallel steel rails laid six inches apart horizontally across the shaft and three feet above it.



Making a cut. Notice the ingenious carriage on which the oxyhydrogen torch is guided

The oxyhydrogen torch was fastened to a carriage traveling on these rails and propelled by hydraulic pressure from the oxygen line. Vertical motion was obtained by another device clamped to the torch and carriage, the speed of which was controlled by a water piston, as shown in the inset above.

Eight cylinders of oxygen were connected with a manifold on the high pressure side and the oxygen was delivered to the torch through four manifold regulators. The gas consumption was 600 cubic feet of hydrogen and 2000 cubic feet of oxygen an hour.

The shaft was cut for use as material for making drop forgings.

How Much Science Do You Know?

DID you ever stop to think how much success in your business or profession depends on a working knowledge of simple scientific facts?

In the shop, the factory, or the office, have you observed that the man who always is ready with the correct answer when a question is put to him is the man who is in line for advancement?

The practical knowledge that leads to larger pay envelopes and greater independence is the knowledge of scientific facts in their useful application.

How much science do *you* know?

Below are a dozen questions chosen at random from hundreds of queries from POPULAR SCIENCE MONTHLY readers. Answer them to the best of your ability, then turn to the correct answers on page 132 and see how nearly you are right. But don't read the answers until you have studied each question thoroughly.

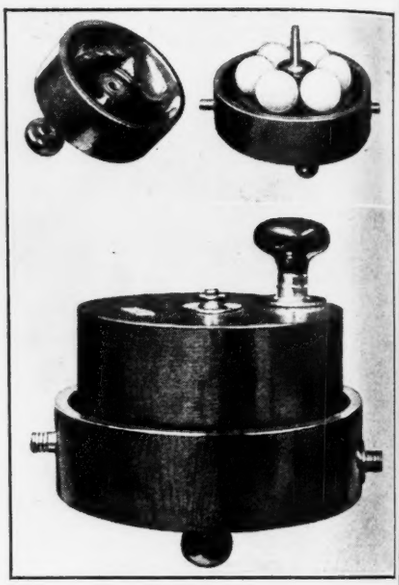
Another test of 12 questions and answers will appear in next month's issue.

1. Why is it hard to run uphill and easy to run down?
2. What are vitamines?
3. How did stars come to be put into constellations?
4. Why is there no air inside an electric-light globe?
5. Can energy be destroyed? Give reasons for your answer.
6. Why does a giraffe have such a long neck?
7. What is an echo, and how is it caused?
8. How much does the earth weigh in tons?
9. What is an electric current?
10. Can we see atoms of matter with a microscope?
11. What is the most valuable of all known metals?
12. What is it that makes a person feel hungry?

Machine Cleans Six Tennis Balls at Once

A MACHINE for cleaning soiled tennis balls consists of an air-tight cylindrical box in two sections. The balls are placed in position in the holder, a soap solution is applied to each ball, the cover is attached, and while a handle rotates the balls, water is run through connections at the base, forming a lather.

After washing, the machine is drained, the cover removed, and the balls are allowed to dry.



Tennis-ball cleaner open and closed

Belgian Mine Shafts Sunk in Columns of Ice

IN ORDER to mine rich coal beds in Belgium that were practically inaccessible by marsh land lying over them, engineers devised a means of sinking the shafts in columns of ice. Two such shafts already have been sunk approximately 2500 feet at a cost of more than $1000 a foot.

The system consists of freezing portions of marshland in the form of cylindrical columns of ice in which the shafts are sunk. To do this several holes about a yard apart are drilled in a large circle around the proposed shaft. A vertical pipe sealed at one end then is sunk in each of these holes and a freezing solution of salt run through them, forming around each pipe a zone of frozen bog that spreads until it joins zones of adjoining pipes.

The refrigerating machines used are based on the evaporation of liquefiable gases, such as ammonia and carbon dioxide. These are compressed and liquefied in coils of a condenser that are kept cool by passing water over them continuously. The liquefied gases then pass through refrigerating coils over which the freezing liquids circulate. As the gases evaporate they create intense cold, freezing the water around them.

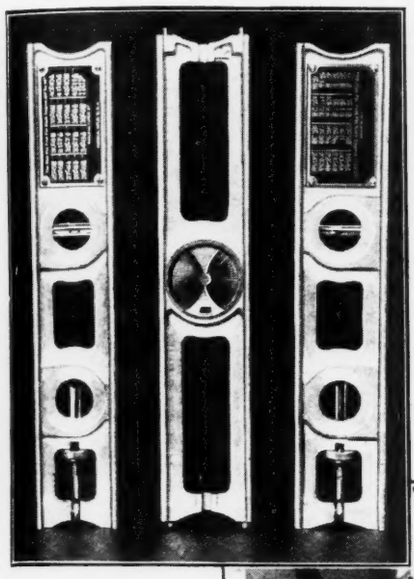
Seven months were required to freeze the first shaft and 21 months to sink the shaft at a rate of little more than three feet a day.

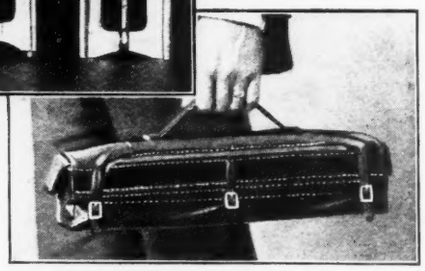
Improved New Level Made in Three Sections

AN IMPROVED 48-inch level of aluminum is made in three 16-inch sections that dovetail together and are securely fastened by thumb-screws. When taken apart, the sections fit into compartments in a leather case. The entire outfit weighs only four pounds.

A valuable feature of the invention is the level indicator. Variations are shown in degrees on a disk. As the level is moved up or down, a weighted indicator across the face of the disk points out the degrees of variation. A table gives the number of inches rise to the lineal foot for each degree.

In addition, the instrument is equipped with a horizontal spirit level and a vertical spirit plumb. A V groove along the top of the level is used for sighting.





Above: The three sections of the new level, showing indicating disk, spirit level and plumb, and calculating table. Right: The handy carrying case

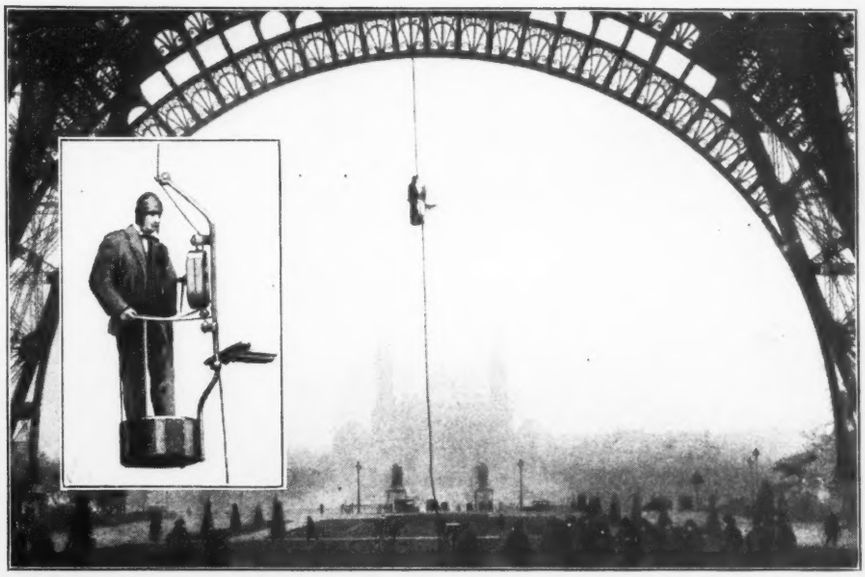
Recent Publications

Chemistry in the Twentieth Century. An account of the achievement and the present state of knowledge in chemical science, prepared under the guidance of a committee representing the scientific societies of England, and edited by Dr. E. F. Armstrong, F.R.S. Illustrated. The Macmillan Company.

Icarus, or The Future of Science, by Bertrand Russell, F.R.S. A pessimistic view of coming scientific achievement. E. P. Dutton & Co.

A Magician among the Spirits, by Houdini. The story of a 30-year investigation of spiritualism told in a thoroughly engrossing way. Harper & Bros.

Automotive Repair, by J. C. Wright, director, Federal Board for Vocational Education. Four volumes of thorough, practical instructions in every phase of automobile repair work. Illustrated. John Wiley & Sons.



Workmen Hoist Selves on Aerial Scaffold

TO REPLACE the cumbersome and sometimes hazardous scaffolding, tackle blocks, and rigging ropes used in construction work, a French manufacturing concern has perfected a device known as a "skyscraper"—a small platform on which a workman can hoist himself to any height required by his particular job.

The platform runs up and down a vertical wire cable and operates on the windlass principle. By turning the crank of a winch the operator can raise or lower himself at will. A braking mechanism holds the car stationary on the cable at any desired point, leaving the operator's hands free.

The cable, suspended from a high point on the structure where it is to be used, will support three tons. A worker with his helper and their tools can be carried.

Constructed entirely of metal, the invention is said to combine the maximum of safety with the minimum of effort.

The illustration shows the invention being tested beneath the Eiffel Tower.

Chinese Trees for Pulp

SEEDS of Chinese fir-trees, which are particularly suited for the manufacture of wood pulp, are being tried out in the United States by the Forest Service in the hope of adding to the nation's pulp resources.

Know Your Car

Running the "Stiff" Engine

MOST automobile owners know that a new car should be run carefully and cautiously at least for the first 500 miles. But did you know that an overhauled engine should be run with equal care after it comes from the shop?

This is because an engine, after an overhauling that includes the fitting of old and new parts together, is in much the same condition, so far as friction is concerned, as when the new parts were assembled originally at the factory. It is "stiff," and demands care in running if it is not to be damaged.

A safe procedure for running the engine under such conditions is as follows:

Before starting the engine, fill the crankcase with half again as much oil as usual. Be sure that the radiator is filled with water and that the fan belt is adjusted correctly.

To every gallon of gasoline add one pint of oil for the first 500 miles.

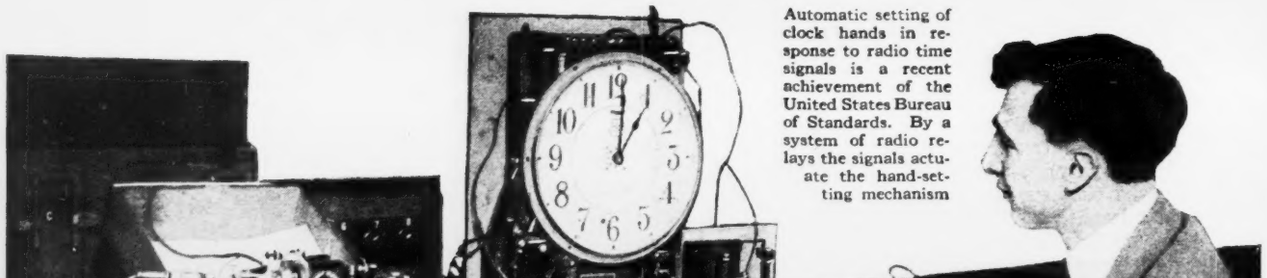
After starting the engine, inspect the oil pump to see that it is working properly.

To make sure that the upper parts of the cylinders, piston rings and pins are lubricated, shoot a small amount of oil from an oil gun into the air intake of the carburetor. Repeat this at intervals for half an hour, or until the lubricating system is found to be working properly.

If the water in the radiator shows a tendency to boil, run a hose to the radiator, and through this feed in cold water as fast as the hot water can be drained through the petcock at the bottom of the radiator.

Let the engine run idle for several hours.

For at least 500 miles do not drive the car faster than 20 or 25 miles an hour.



Automatic setting of clock hands in response to radio time signals is a recent achievement of the United States Bureau of Standards. By a system of radio relays the signals actuate the hand-setting mechanism

What's New in Radio Invention

By Jack Binns

America's foremost writer on radio

WILL the perfect loudspeaker be produced this year? Ever since the advent of broadcasting it has been realized that the "speaker" controls the future of the science. In the United States, England, and France every available effort is being concentrated upon the development of this instrument.

Dr. C. W. Hewlett, an American scientist, has produced a new speaker that has no iron in it at all. Neither does it require a horn. It is based on the induction principle.

Instead of the usual horn, it has an aluminum diaphragm mounted in a frame and surrounded by flat coils of wire close to it. The coils carry direct current that produces a radial field over the diaphragm, which in the largest model is thirty-six inches in diameter. The same coils carry the amplified voice currents, and the interaction between the currents causes the diaphragm to vibrate.

THE present model, however, is suitable only for very loud work.

An entirely different method is being employed in a speaker developed in England. This is based on the electrostatic principle, developed by two Danish engineers, Johnsen and Rahbek. It involves the phenomenon existing when a semi-conducting body, such as gelatine, is brought in contact with a metallic surface, and a difference of potential maintained at the point of contact. This causes an adhesion between the two objects. Any change in voltage will cause a corresponding change in the degree of adhesion.

In the new speaker, advantage is taken of this effect in the following manner: A metal cylinder is slowly rotated in close contact with a band of gelatine covered on the outside with tinfoil. One end of the gelatine is connected with a spring, the other with the diaphragm of a loudspeaker similar in construction to the sound box of a phonograph.

In operation, a steady voltage is maintained across the tinfoil. This produces a steady adhesion between it and the gelatine, which maintains a steady pull on the diaphragm. The pulsating current from the radio amplifier causes changes in the adhesion, and these in turn actuate the diaphragm, causing it to give off sound.

In France most experimental work with speakers is being concentrated on large diaphragms that eliminate the necessity of horns. It is recognized that the latter merely concentrate the sound waves. They do not in any way amplify their volume; in fact, they absorb some of the energy.

For the first time in history speeches and entertainment have been broadcast from a steamer at sea. Above is a view of station WSN aboard the liner *Leviathan*, from which the program was sent. A radio engineer is seen testing the wave length of the station with a crystal set, preparatory to broadcasting

The Hunt for Static

SCIENTISTS have come at last to the realization that the best way to eliminate the evil effects of static is first to learn its habits, where it comes from, and the hours it keeps. With an intelligent knowledge of these facts more progress can be made toward its elimination than by any of the haphazard methods at present employed.

Somewhere off the New England coast engineers of the American Telephone and Telegraph Company's laboratories have installed an automatic recording device that makes a permanent record of the strength, duration, and direction of all static discharges within range of the sensitive apparatus.

In the short time it has been in operation two very important facts have been learned regarding the enemy of radio. First, it has been found that there is a marked decrease in the value of static every morning at sunrise, irrespective of weather conditions. Second, the observations have indicated that most of the static received on the eastern coast of the United States originates in the southwest. The conclusion drawn is that if a

reflecting wall separates day and night, it follows that as this wall passes a station it will reflect or refract the static waves from the southwest and act as a shield to reduce the intensity of the static at sunrise.

The apparatus employed consists of a loop antenna that picks up the static. A loop is highly directional, and therefore indicates the direction from which the static is coming. The loop is rotated automatically, and the energy picked up in this manner is passed into a radio-frequency amplifier. The output from this is fed into the heating elements of a thermocouple that operates a recording galvanometer. In addition, the apparatus includes a means for measuring the intensity of the static noise.

Safety for Air Mailmen

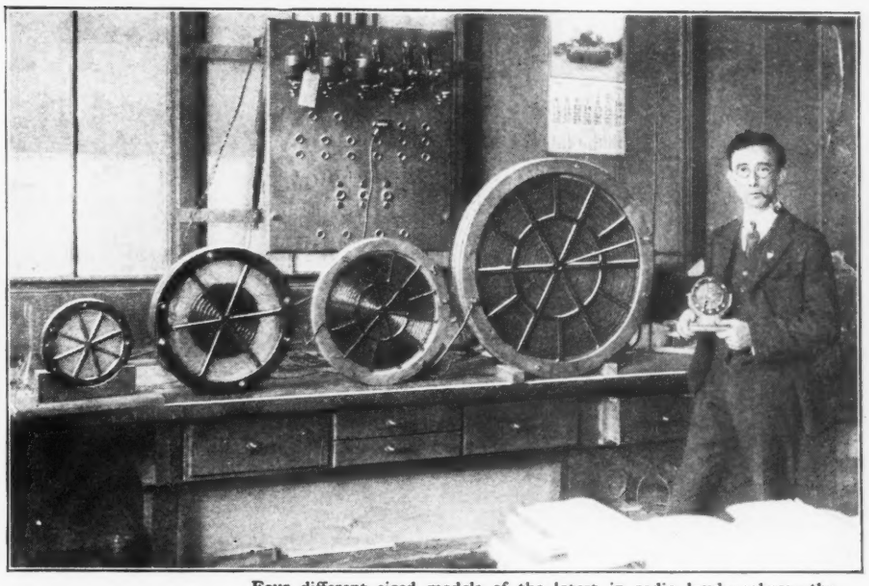
ON JULY first the new transcontinental air mail service was inaugurated. Radio is playing a remarkable part in the safety of the aircraft employed in this service. All the landing fields are linked with a radio system that approximates in effectiveness the block system of signaling on railroads.

Probably the most remarkable of the safety measures, however, is the newly developed "field localizer." This consists of an electric wave spread above the landing field somewhat in the shape of an inverted cone. The apex of the cone is on the landing field, and the base up in the air. With its aid, an airplane caught in a fog can be guided safely to a landing, because the "wave field," narrowing down to a cone, becomes more accurate as the machine nears the ground.

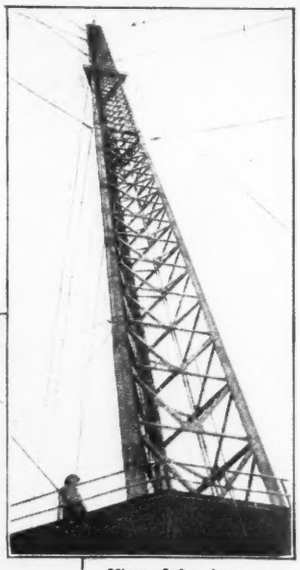
The pilot knows he is in the vicinity of the landing field as soon as he picks up the "wave field" with his instruments. Then by carefully maneuvering his machine downward, he can reach an altitude where he will be able to see the landing field through the haze.

Direction finders also are to be installed on the transcontinental air-mail ships. These will enable a pilot to steer a straight course between scheduled stops should he be overtaken by unexpected foggy weather.

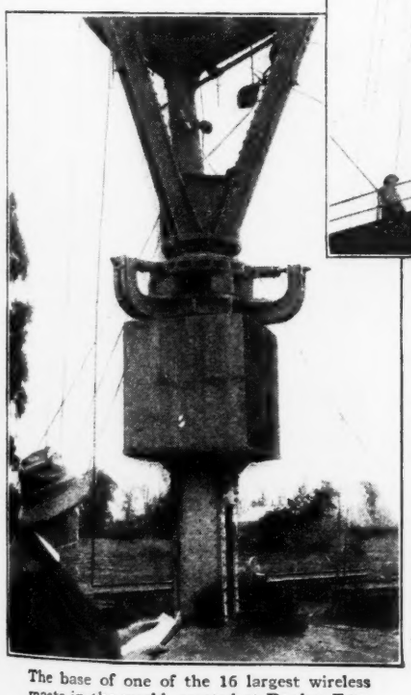
There is no doubt that aerial navigation and radio are bound together inseparably. In fact, without radio, organized flying on scheduled time-tables would be impossible.



Four different sized models of the latest in radio loudspeakers—the hornless induction loudspeaker developed by Dr. C. W. Hewlett, physicist of the General Electric Company, who is shown above in his laboratory. The largest of the models, 36 inches in diameter, has been installed near an auto-tourists' camping-ground at Schenectady, N. Y., and can be heard 500 feet away, insuring entertainment for a large audience



View of the giant mast, looking upward



The base of one of the 16 largest wireless masts in the world, erected at Rugby, England. They will make it possible for London to telephone New York. Each great mast weighs 140 tons and is 820 feet tall

Facts about Broadcasting

SOME interesting figures have just been compiled regarding broadcasting stations. These show that 79.3 per cent of the stations licensed in this country are operating on less than 500 watts, an amount of power generally considered inadequate. There are 93 stations with 500 watts output, and 14 using more than that amount.

Another interesting analysis shows that 53.8 per cent are operated by radio and electric companies, dry-goods stores, newspapers, and other private corporations. Of the remainder, 17 per cent are worked by governmental agencies, federal, state and municipal, and 3.5 per cent by churches.

There is a strong tendency to bring about the elimination of the 79.3 per cent using less than 500 watts and to concentrate on the better type of broadcast stations strategically located with regard to centers of population

Marconi's Remarkable Work

REMARKABLE progress apparently is being made by Marconi and his assistants with the "directed beam" system of radio communication on wave lengths of one to 15 meters. The latest reports indicate that successful telephone communication between England and Argentina has been achieved. On this occasion the Argentinian Minister of Agriculture, Dr. Thomas Le Breton, who happened to be in England, spoke with War Minister Justo in Buenos Aires.

As soon as Marconi's work has been brought to a successful conclusion, it will be possible to put hundreds of transatlantic radio-telephone channels into operation without interference, and with a fair measure of secrecy.

Radio and the Railroads

RADIO probably never will supplant the existing systems of railroad signaling and control entirely. It will, however, make possible direct communication at all times with moving trains. This is of far-reaching importance. Its value when storms disrupt the telegraph lines cannot be overestimated.

The Pennsylvania Railroad has just completed experiments with special stations erected at Camden, N. J., Pittsburgh, Chicago, and St. Louis. The results obtained with moving trains were very successful. The company now is considering the advisability of establishing radio stations as auxiliaries to its telegraph and telephone lines.

One of the possibilities of this system is that engineers of trains can keep in direct touch with the dispatcher's office at all times during the trip. This will make possible a strict control of each train, thus minimizing the danger of accidents. This is an immediate possibility. Another possibility of the near future involves telephonic communication between business offices in cities and passengers aboard express trains.

Back-Stage with "Radio Mike"

How Broadcasters Send Realistic Drama over the Air

By W. T. Meenam

IF YOU ever have listened to drama over the radio, have you wondered how effects of rain, thunder, wind, and similar noises are created before the microphone in the studio of the broadcasting station, to add vivid reality to the spoken play?

Successful transmission of a dramatic production by radio is greatly dependent upon sound properties to take the place of stage action. Thus atmosphere is created and the imagination of the hearer is stimulated. To obtain this atmosphere many devices are improvised to suit the needs of a particular production. Considerable experimenting often is necessary to produce the sound desired.

It is easy to imagine how such common noises as the slamming of a door, the breaking of glass, the barking of a dog, or the ringing of bells are reproduced for radio audiences. In fact, such sounds have offered few obstacles to broadcasting producers. But when the manuscript of a radio play calls for such a spectacle as a forest fire, with crashing trees and roaring flames, what then? If the play is to be broadcast successfully, a vivid portrayal of raging conflagration becomes vital.

Just such a problem confronted the producers of a drama called "The Storm," which was broadcast with striking effect by Station WGY, Schenectady, N. Y. At the climax of the play a great forest fire was to cut off the hero, heroine, and rival from the rest of the world. The way in which the effect of this dramatic setting was sent "over the air" was remarkably ingenious, especially since it was produced before the microphone with such simple instruments as a gasoline blowtorch, matches, and paper.

The torch produced the effect of rushing wind and flame. The paper, crushed close to the microphone, sounded to radio audiences like the crackling of burning tree branches. The breaking of small matches produced the realistic effect of the breaking of huge tree trunks.

In the production of another play, entitled "The Fortune Hunter," a rainstorm was necessary. Instead of waiting to broadcast on a stormy night when the real rain might be available, a thoroughly realistic effect was created simply by rolling dried peas through a paper tube directly in front of the microphone. The paper tube magnified the sound so that to distant radio listeners the effect was a first class rainstorm.

The staging of a fight scene before the microphone in such a way that the thrills will not be lost to the invisible audience is surprisingly ingenious. In such a scene from "Pierre of the Plains," which was broadcast not long ago, "*Jap*" *Durking*, the villain, fires at *Pierre* from ambush. *Pierre* feigns death and falls in the dead leaves carpeting the forest. Then, as *Durkin* approaches, *Pierre* grapples with his enemy and kills him in a desperate hand-to-hand conflict. *Pierre* rides away on his horse.

In "staging" this scene, the shot fired by the villain, of course, is produced by a revolver. In the hand-to-hand fight the actors grapple knee-deep in onion-skin paper, and a microphone on the floor picks up the sound of the rustling paper leaves as they are scattered in the struggles of the men. At the end of the battle, the sound of the horse's hoofs as *Pierre* rides away is produced by drumming with sticks on a wood surface.

In order to have within easy reach frequently used bells, the "property man" of the WGY "radio theater" constructed a bell board containing all the necessary combinations such as doorbell, telephone bell, call bell, and buzzer, mounted on one board and connected with batteries. Burglar, ambulance, and fire alarms, a clock chime and tap bell also were included.

The entrance or exit of a character in a radio drama must be conveyed to the invisible audience by the audible closing of a door. This is one of the peculiar conventions of dramatic broadcasting. Generally, in dramatic production, a softly closing door is desirable and conventional, but over the air the actual sound of the closing of the door is the only means of denoting the exit or entrance of a character. Therefore a small portable door of thin oak in a specially mounted frame with peculiar resonance was constructed so that the noise of closing it could be transmitted easily and so that the turning of the key in the lock also would be noticeably audible to the thousands of unseen "play-goers."

Onondaga Indian braves, in full regalia, enacting an Indian war dance before the microphone in the broadcasting studio of Station WGY, Schenectady, N. Y. This probably was the first time that a war dance had been broadcast by wireless

Broadcasting the fight scene in "Pierre of the Plains." A revolver fires the shot intended for Pierre. Then the actors portraying Pierre and his enemy grapple knee-deep in onion-skin paper, rustling the "leaves" in their realistic struggle

Edward H. Smith, director of the WGY players, with the bell board and door used to produce sound atmosphere for the radio drama. The bell board contains door, telephone, clock chime, alarm, tap bells and buzzer, all connected with dry batteries and operated by the pressure of a button. The entrance and exit of characters are indicated by the sound of the opening and closing door

How to Build a Super-Heterodyne

Part I—The First Detector and Two-Stage Amplifier Units

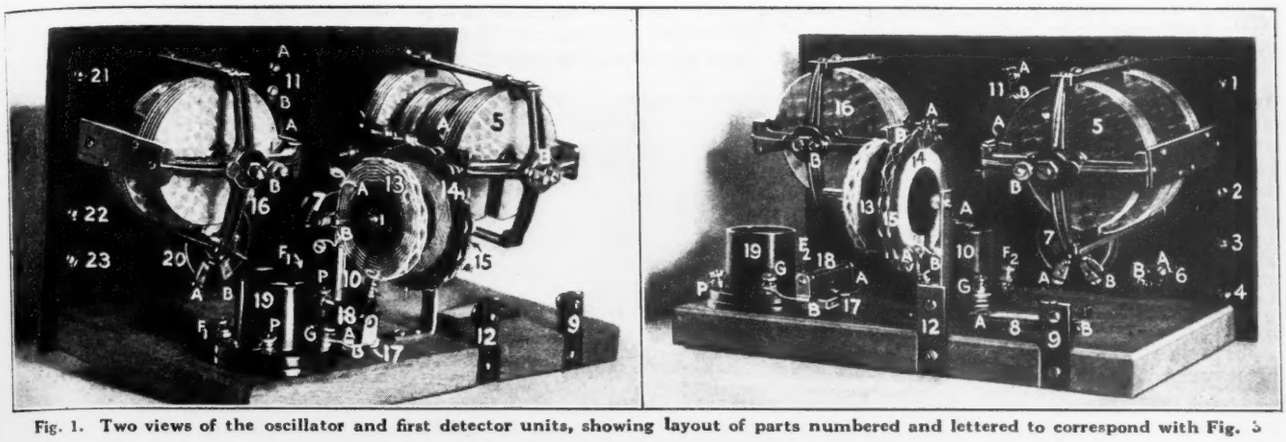


Fig. 1. Two views of the oscillator and first detector units, showing layout of parts numbered and lettered to correspond with Fig. 3

By
Joseph Calcaterra
Radio Editor of Popular Science Monthly

THE super-heterodyne is recognized generally as being the most sensitive and the most selective of all radio receiving sets. For that reason the dream of almost every real radio fan is to own one sooner or later.

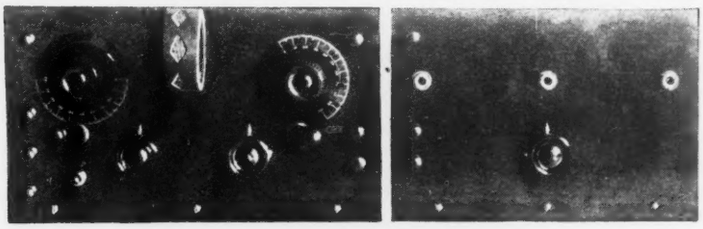
Because of its size and intricacy, however, many persons who like to build their own sets have hesitated to build this king of radio instruments. Yet such a feat is entirely possible.

In fact, it is in response to many requests from POPULAR SCIENCE MONTHLY readers that I am describing, in this and next month's issues, just how to build the super-heterodyne.

For the sake of simplicity, as well as utility, the set is constructed in three units. It can be used not only as an eight-tube super-heterodyne receiver, but, with slight changes in connections, can be adapted for use as a simple three-tube non-regenerative honeycomb-coil receiver for reception of local stations with an outside aerial.

This month I shall describe the construction of the oscillator and first detector unit, and the two-stage audio-frequency amplifier unit.

Next month I shall tell how to build the intermediate amplifier and second detector unit. In addition, I shall give complete instructions for connecting the units, and tell how to operate the complete receiver.



Front view of panels of detector (left) and two-stage amplifier units, showing controls

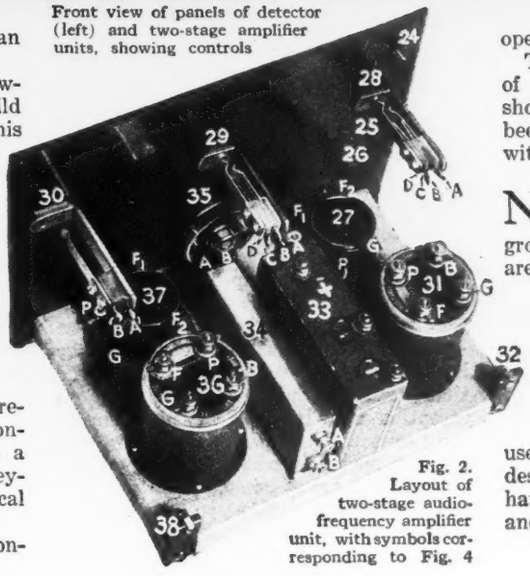


Fig. 2. Layout of two-stage audio-frequency amplifier unit, with symbols corresponding to Fig. 4

The symbols on the wiring diagrams of the detector and amplifier units, shown at the bottom of the page, have been numbered and lettered to correspond with the various parts on the photographs.

NUMBERS 1 and 2 of the detector unit (Figs. 1 and 3) are the aerial and ground terminals respectively, when such are to be used. When a loop aerial is used, one end of the loop should be connected with terminal 1; the other end with terminal 2.

Number 3 is the negative A-battery terminal, and No. 4 the positive A-battery terminal.

Number 5 is the variable condenser used to tune the oscillator circuit to the desired frequency. This condenser should have a capacity of about .001 microfarad and should be provided with a Vernier

(*Continued on page 133*)

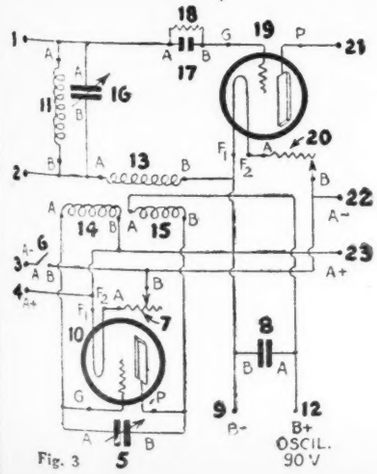


Fig. 3

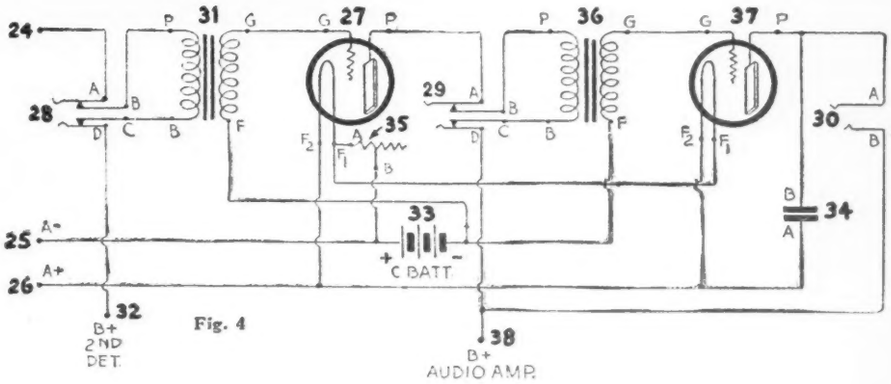


Fig. 4

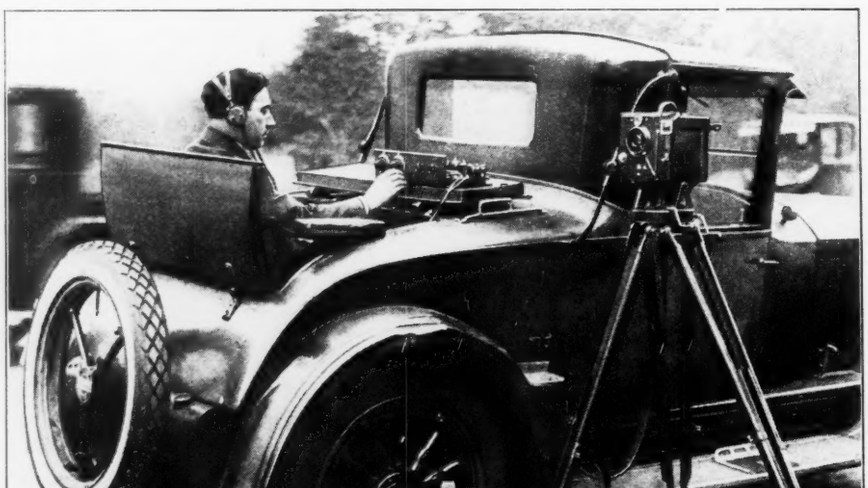
At the left is the complete wiring diagram for the oscillator and first detector unit shown in Fig. 1. The diagram above is for the two-stage audio-frequency amplifier unit shown in Fig. 2. In each case the symbols correspond to the numbered and lettered parts in the photographs shown above

Radio Hints for Everybody

ALTHOUGH you cannot eliminate static, you can, without much trouble, cut down the amount of static that crackles in the head phones or loudspeaker of your receiving set.

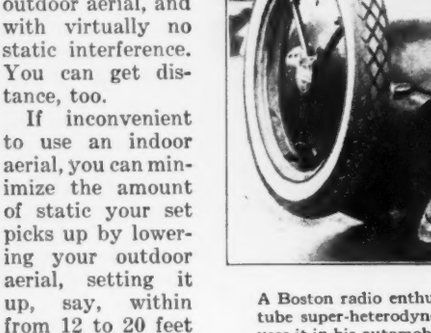
The surest way to do so is to use an indoor aerial — either a loop, or a single wire stretched in the attic, along a hallway or around a picture molding. With an aerial of this sort you can pick up local programs just as satisfactorily as with an outdoor aerial, and with virtually no static interference. You can get distance, too.

If inconvenient to use an indoor aerial, you can minimize the amount of static your set picks up by lowering your outdoor aerial, setting it up, say, within from 12 to 20 feet of the ground. And even if you cannot, for some reason, try any of these things, you can keep static down by tuning in the local stations only.



© Keystone

A Boston radio enthusiast has perfected a six-tube super-heterodyne set so sensitive that he uses it in his automobile, as shown above, without antenna or ground wires. He says he has heard 25 stations from his car in one location, and is always assured of entertainment



This compact battery charger, plugged into an electric-light socket, is designed to recharge a radio storage battery overnight. An aluminum cover protects the apparatus, which is said to deliver as much current as 7½ amperes, consuming only 75 watts

MOST people, when they buy radio sets, put up the best aerials they can. Few, though, bother much about their ground connection. The nearest and handiest path to the ground usually suffices, whether it be a water pipe, a gas pipe, or part of the house's steam-heating system.

Now, the "ground" is almost as important an aid to good reception as the aerial, and for this reason you should spare neither pains nor trouble in supplying it.

If possible, it should be a special iron pipe, or plate, buried in the ground a few feet from the wall of the house, and it should be as close to your receiver as you can get it. In other words, the lower floor of a house is the best location for a radio set, and the ground connection should be made direct, not through a complexity of water pipes.

IF YOU have a portable set, or if you remove your stationary set to camp or hotel during your vacation, remember that various conditions affecting radio reception may be decidedly different in the new location. Hence, you must not expect your receiver to function the same as when you are at home.

The dial settings that you have charted for various stations, for example, probably will not bring in those stations. The sensitiveness and selectivity of your receiver also may appear to be impaired. There is no way to remedy these conditions except through experiment.

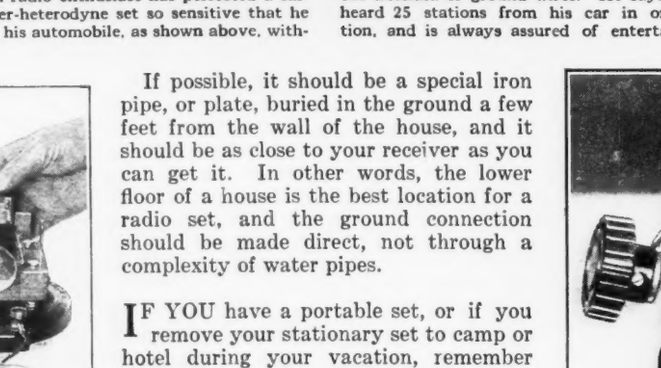
Rechart your dial settings. Raise or lower, lengthen or shorten your aerial. Be certain that you have a good ground connection. Don't, however, attempt any drastic alteration of the set itself, for you may thereby store up trouble for yourself after your return home.

SOMETIMES the source of radio troubles is elusive because it is in such an obvious place, you never think of looking for it there. A scratching noise, for example, easily may be caused by loose phone connections.

More than one fan, after spending hours inspecting receiver, aerial, and ground in a search for the possible causes of the scratch, has discovered the trouble in a loose connection in his phones.

When the receiver "scratches," look first to the phones. Connect the phones, turn on the tubes, and shake the phone cord. If the trouble is there, you soon will know.

The newest thing in vario-couplers is this ingenious combination using a spider-web primary, spider-web secondary, and a separate three-turn coupling coil. All windings are so arranged that the electrostatic coupling is practically "zero"



You can talk through your loudspeaker simply by connecting the head set across the primary of the transformer of the first stage amplifier, and speaking into one of the phones, the B battery being connected as usual

Riding the Storm to Make the Air Roads Safe

By C. LeRoy Meisinger
Meteorologist, United States Weather Bureau

Courtesy U. S. Air Service

Doctor Meisinger as he appeared just before he rode to his death in the storm

THE meteorologist's laboratory is the atmosphere itself. Unlike workers in many other fields of science, it is not easy for the meteorologist personally to work in more than a small portion of his laboratory. His efforts usually are confined to that portion of the atmosphere that lies next to the ground.

The United States Weather Bureau, however, in collaboration with the Army Air Service, recently has undertaken a project that involves the actual making of flights by one of its representatives. A series of flights in spherical free balloons now is being made at the Air Service's lighter-than-air station at Scott Field, Ill.

While the Weather Bureau does not expect to make sweeping "discoveries" in undertaking these flights, it does hope to gather data concerning air movements at free-air levels that can be *observed* in no other way.

Where does a given small mass of air travel in the course of several days? As we stand out of doors and feel the air blowing past us, what do we know of the path over the earth's surface that a certain particle of air is following?

Unless the air is considerably stirred up by local temperature inequalities, at a given level it will move approximately horizontally. Close to the surface, topographic irregularities also play an important part in introducing vertical motions into the air; but at higher levels this is not so conspicuous.

Therefore, if we may send a manned free balloon to some stated level, cause it to maintain its elevation as constantly as possible, and have the observer note carefully at all times the course of the balloon, the resulting path will be a close approximation to the movement of air at that level. This is precisely what is being attempted at Scott Field.

The work is dependent for its success upon the knowledge of the track of the balloon. In clear weather, this means only close attention to maps as the balloon proceeds. But when the earth's surface is obscured by clouds, there are two means of checking the path: One is to drop weighted postcards that may be found and returned by the finder with a notation as to the time and place of finding. The other is to determine the balloon's position by astronomical observation according to standard methods of navigation. This latter method is used only when the sky is clear overhead.

THE balloons being used are of the spherical type employed for military training and balloon racing. The capacity is 35,000 cubic feet and hydrogen is used as the buoyant gas.

The total lift is about a ton, approximately half of which is carried as expendable ballast. Under favorable weather conditions, such a balloon might be able to remain in the air from 36 to 40 hours, but usually this is not possible; and, when rain falls on it long, the added weight necessitates so rapid an expenditure of ballast that the flight often is terminated within from eight to 10 hours, sometimes even less.

Besides the fundamental work outlined above, data are being gathered in connection with other investigations. For instance, dust samples obtained at various elevations enable one to know the number of dust particles in a given volume of air. The vertical diminution or increase of dustiness is of considerable importance as a basis for studies in visibility, which is so important in aerial navigation.

Equally important to visibility is sky brightness. Equipment is carried also for the measurement of this.

A radio receiving set is carried in the balloon, and the forecaster at Washington is able to communicate to the personnel of the balloon bulletins concerning the latest changes in weather conditions in the region in which they are flying. These bulletins have been very valuable.

THE first flight of the series was made by the author with Lieut. L. A. Lawson on April 1 and 2, 1924, and subsequent flights have been made with Lieut. James T. Neely, both excellent pilots of the Air Service. At the time of writing six flights have been made.

The ballooning is being carried on under weather conditions that are not always the most favorable from the standpoint of comfort and safety; but, thus far, the flights have been most successful and of the greatest meteorological interest. It is work in the meteorologist's laboratory that brings to the workers the thrill of adventure.

A Martyr in the Cause of Science

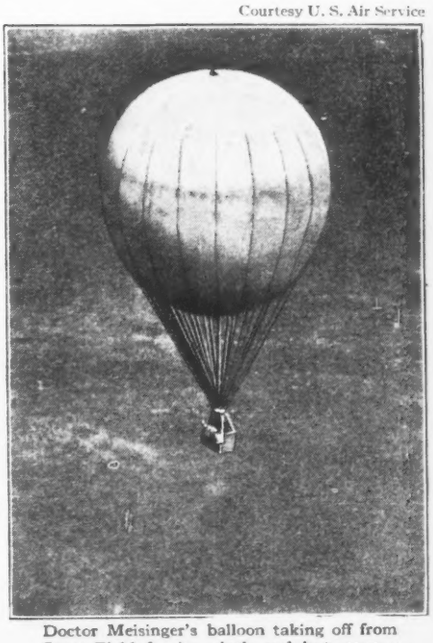
BEHIND the recent brief newspaper accounts of the tragic death of Dr. C. LeRoy Meisinger, expert meteorologist of the United States Weather Bureau, lies as dramatic a tale of bravery as ever came from a field of battle—another heroic chapter in the ceaseless adventure of science into the strongholds of the unknown. Doctor Meisinger and his pilot, Lieut. James T. Neely, died in action near Bement, Ill., when lightning destroyed the free balloon in which they had deliberately set out to ride the storm.

Doctor Meisinger proposed to make the air safer for aviation by studying the habits of storms so as to forecast them unfailingly. It was his idea that this could be done best by taking part in a storm, allowing himself to be buffeted about in its relentless fury while he charted its movements and air currents.

The fatal flight was the ninth of a series of hazardous expeditions from Scott Field, Ill. On the first voyage Doctor Meisinger drifted to Waterboro, S. C., where a landing was effected to prevent being swept out over the Atlantic Ocean. The second voyage was ended to keep from being blown over Lake Erie, and on the fourth flight death was narrowly averted, when the balloon, after hovering over storm-swept waters of Lake Michigan five hours, was blown back into Wisconsin.

At the beginning of the investigations the Editor asked Doctor Meisinger to describe his work for the readers of POPULAR SCIENCE MONTHLY. The article on this page was written by Doctor Meisinger while his balloon was being inflated for the seventh flight. It breathes the modest zeal with which a true hero faced unknown dangers in the cause of science. Throughout, he hides his own identity behind that of the service for which he gave his life.

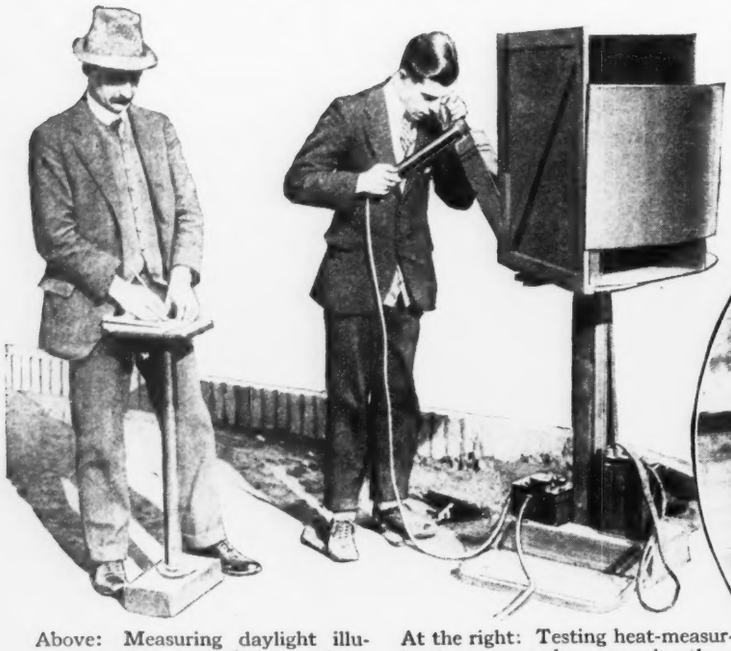
Courtesy U. S. Air Service



Doctor Meisinger's balloon taking off from Scott Field for its ninth and last voyage

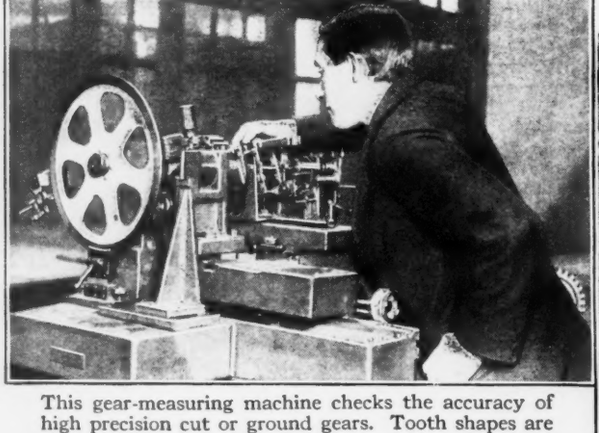
New Scientific Aids to Industry

To promote the production of scientific machinery for industry, the British National Physical Laboratory at Teddington, Middlesex, is conducting experiments on a large scale in every branch of physical science. These pictures show some of the most interesting tests

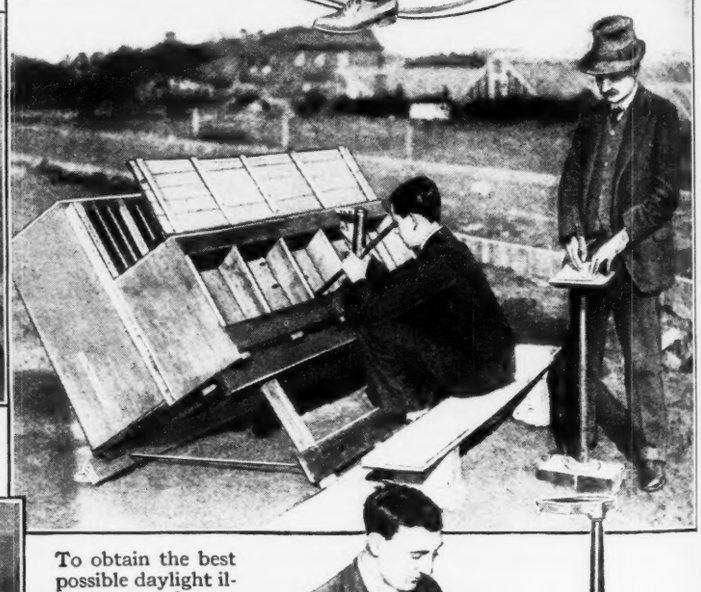


Above: Measuring daylight illumination from four quarters of the sky by means of a special triangular screen and brightness recorder

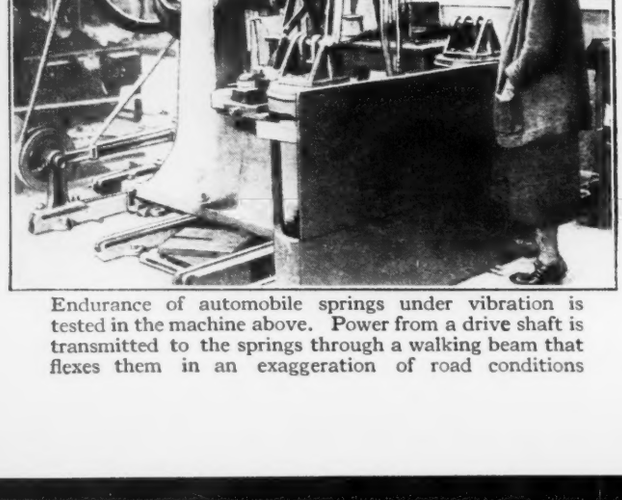
At the right: Testing heat-measuring instruments by comparing them in heat radiated through an observation hole in a special furnace



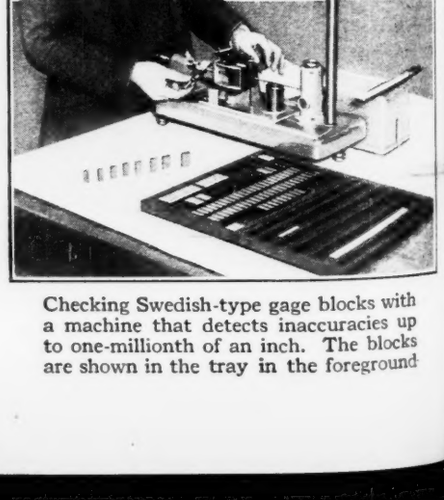
This gear-measuring machine checks the accuracy of high precision cut or ground gears. Tooth shapes are reproduced on smoked glass by means of a pantograph



To obtain the best possible daylight illumination for an extension of the famous Tate Art Gallery in London, experimenters are shown above measuring the daylight factor in a small scale model of the structure. The measurements are made with a special daylight meter called a "hermera-photometer," and are recorded by the observer shown at the small stand



Endurance of automobile springs under vibration is tested in the machine above. Power from a drive shaft is transmitted to the springs through a walking beam that flexes them in an exaggeration of road conditions



Checking Swedish-type gage blocks with a machine that detects inaccuracies up to one-millionth of an inch. The blocks are shown in the tray in the foreground

Where Is the Automobile Going?

An Expert's Forecast of Improvements in the Next 25 Years

By Leslie V. Spencer, M.E.

WHERE is the automobile going? What sort of motor vehicles will the drivers of the future operate?

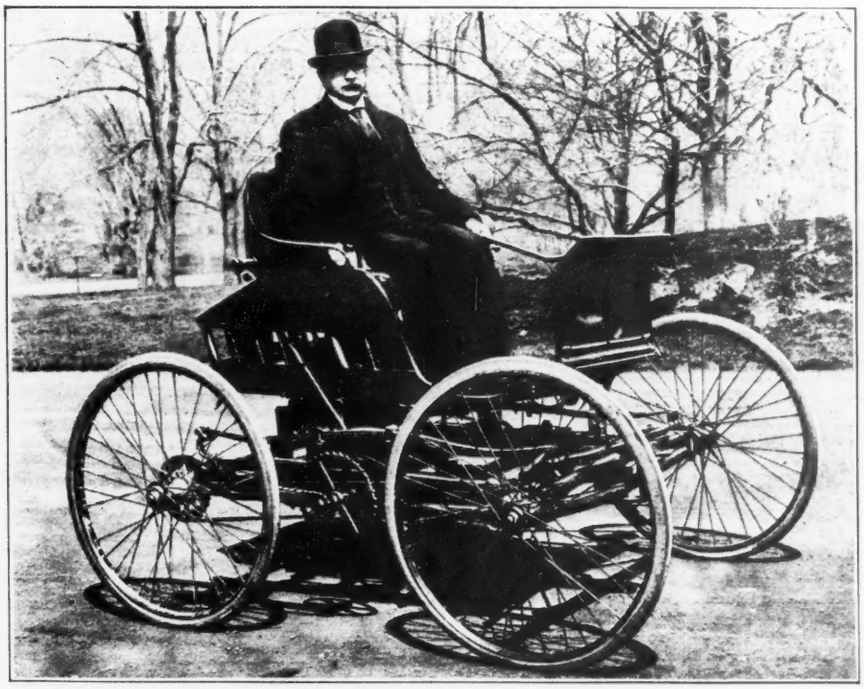
At the rate of development maintained during the last 25 years, the motorist of 1950 will laugh heartily at our finest gasoline creations of today, just as we cast an amused eye upon the horseless carriages of 1900, with their funny dashboards, their chuggy engines underneath, and their short wheel base. For undoubtedly the forces that have developed the motor-car to its present degree of perfection will continue their influence.

The quality and price of fuel, for example, will play an important part, for gasoline transportation units always must take the fuel problem into consideration. Then, the demand for power along with small bulk and low price must be reckoned with. Comfort, dependability, utility—these also are controlling factors.

Each year sees a greater tendency toward making cars easier to drive and simpler to handle. Beginning with the self-starter some years ago, development along lines of simpler operation has been marked, until today cars are very easy to handle, even by the frailest woman driver. Steering gears have been refined in every particular, gearsets have been studied closely with the idea of bringing the shifting down to the least arduous degree possible. Pedal actions and accelerator mechanisms have been arranged so that brute strength is not essential to efficient handling. All these factors have tended to bring motor-car operation within reach of an ever-increasing number of persons.

YET there is still much to be done along these lines; for, after all, with most cars, it is still necessary to shift gears around to change from one speed to another. Undoubtedly the day is not far off when there will be none of the manual gear lever manipulation almost universal in gasoline cars today. Some form of automatic or semi-automatic change of speed relation is in the offing. It will not be a tacked-on mechanism to go through the motions required at present, but it will be an integral part of whatever type of gearing is used.

Looking a little further into the future, undoubtedly we shall laugh whenever we inspect cars with any sort of intermediate system of gears at all. The gasoline engine of the years to come will run so smoothly and have such a nearly continuous flow of power that such a thing as drive through gears will be unnecessary.



America's oldest automobile as it appeared in 1893, driven by Elwood Haynes, its builder. Comparison of this little chugging machine with the powerful, smooth-running car of 1924, shown below, illustrates strikingly the amazing development of the automobile

Steam cars today do not need gearsets because the steam engine develops a steady power flow at any speed, whereas the power of a gasoline engine is intermittent. As gasoline engines have developed, however, they have approached nearer and nearer to the constant torque of the steam engine, and it is logical to expect this development to continue.

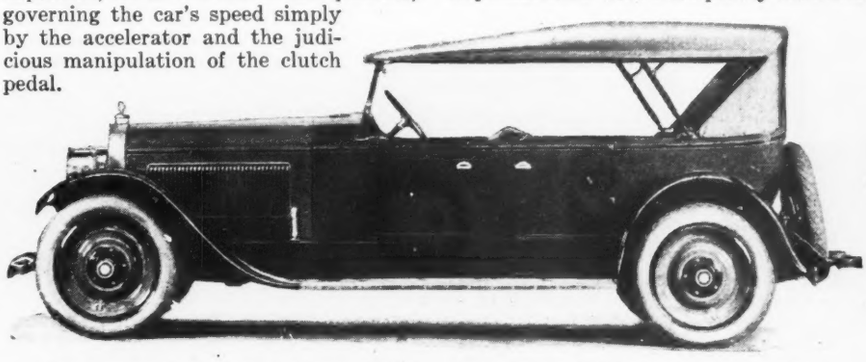
This will mean an entirely new satisfaction in driving. It will mean that you will simply start your engine, move a connecting lever while the clutch pedal is depressed, let in the clutch and proceed, governing the car's speed simply by the accelerator and the judicious manipulation of the clutch pedal.

There will be no shifting of gears back and forth, for there will be no gears to shift. The drive will be direct from the engine to the rear axle, just as a great many racing cars are built even now.

Already we have hints of changes in gearsets. One prominent make of motor car is out with a gearset that effects changes of speed between driving and driven shafts without meshing or demeshing any of the gears. This means less shifting trouble, since one of the chief difficulties in shifting gears without grinding is that teeth of one gear actually must slide into engagement with those of another.

IN THE new gear mechanism referred to, an ingenious shifting of keys is effected, the shaft thus picking up the desired gear, which is never out of engagement with its mating gear. The motions of gearshifting are gone through with just as with any other gearset, but the resulting movement of the parts is not the same. This interesting development is, without doubt, the forerunner of a new order of things in the transfer of the power from engine to rear wheels.

The entry of non-transmission vehicles into the field may be along with multi-cylinder engines such as we have not yet seen. One way of bringing about greater motor flexibility is to increase the number of cylinders. Although so far we have not gone beyond 12 cylinders in commercial cars, it is not at all improbable that the gasoline engine of 1950 may have 24 or 48 little cylinders so arranged that the power impulses come with a frequency that will



The touring-car of today, with its tremendous power, its graceful lines, and ease of operation, may seem as crude and curious an oddity to the motorist of 1950 as the horseless carriage of 25 years ago, with its chuggy engine and odd-looking dashboards, appears to us

be the next thing to continuous flow.

In that future day when there are no gearsets at all, cars naturally will be much lighter and simpler. Simplification means increased efficiency and dependability. The simpler the mechanism, the cheaper it is to manufacture, and the less the public has to pay for it.

ALSO, when you reduce the number of parts, with consequent reduction in weight, you make a car cheaper to run. Less weight means less power required to operate the machine, and hence less fuel cost. Is it, therefore, too much to say that we are almost on the threshold of the era of cheaper car operation as well as cheaper cars? Even if nothing is done save to cut out gear mechanisms, this era is assured.

Another factor that has its influence on reduction of weight is the constant progress in metallurgy. Metals used today in car construction are far in advance of what they were a few years ago. The Ford car, for example, would not be possible at the price nor the weight if the present vanadium steel alloys were not used most extensively. Alloys with aluminum, many of which have been perfected within the last few years, mean lightness with real strength, a most desirable combination.

We are certainly nowhere near the ultimate in the development of combination metals, for the metallurgical laboratories of every big concern employing metals constantly are trying to come nearer to the ideal type of metal alloy for any given purpose. Perhaps in no industry is this activity more pronounced than in the field of car building.

The cost of gasoline is going to force the development of engines which will efficiently use heavier oils that can be purchased for less money. Fuel oils that cost from five to seven cents a gallon are not adaptable now for motor-car use, but the days ahead will undoubtedly force the development of power plants that will run on such cheap fuels.

One of two things soon must happen if internal-combustion engines are to keep other types from crowding them out as the means of motor-car propulsion. Either present-day gasoline must come down radically in price, which seems highly improbable, or cheaper oils must be brought into use. As the number of cars increases, competition and public insistence will force engineers and inventors to develop ways and means for cheaper car operation.

Think what it would mean to the automobile public if every gallon of oil brought from the ground could be used in nearly its crude state in the operation of cars! Perhaps going all the way back to the oil-well is too big a step, but at least the type of oil now used by ships and for similar purposes ought to come eventually into motor-car use—a step forward that means almost unbelievable advance.

BUT when the day comes that we have direct-drive cars propelled by heavy-oil engines, then we shall have gone as far as we can along the internal-combustion-engine path. With the rapid strides electricity is taking, scientists and engineers predict a day when we shall have wireless power transmission for automobiles. The air will be filled with tremendous electrical energy from power stations, perhaps municipally operated. Each user of such power will have some sort of collector device, and he will be licensed and charged so much a month, say, depending upon what amount of electric energy his intake meter indicates he has drawn from the ether.

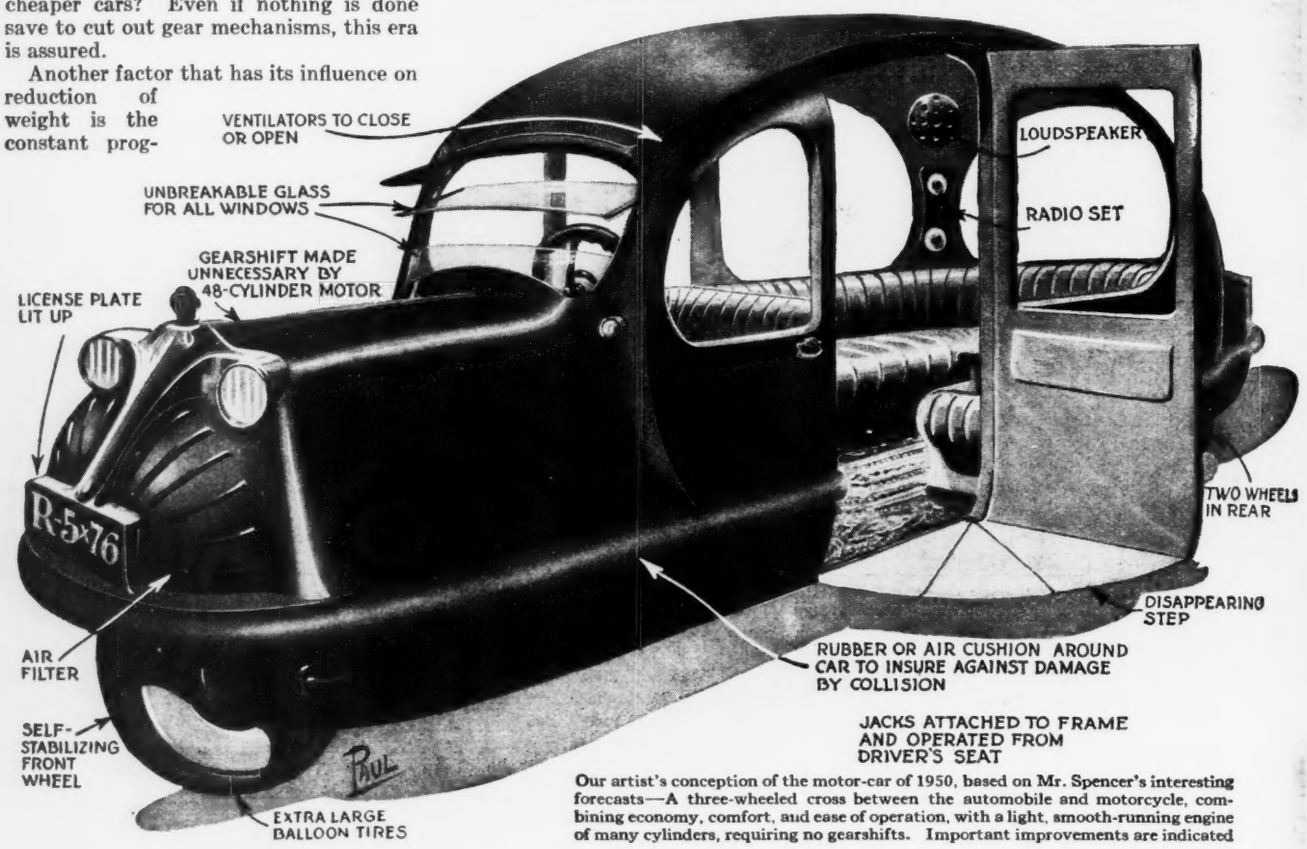
The big factory will have its giant collector of power; each automobile will have, instead of an engine as we know it, a collecting device in proportion to the size of the vehicle. Then from this collecting arrangement the power will enter an electric motor to drive the car.

LOOKING still further into the future, one well can imagine the day of the combined airplane and road vehicle. Obviously, for short runs such a machine would be operated on its wheels, but once out of the city, or other congested area, it would stretch its wings and take to the air for long-distance hops. All one has to do to realize that such development is possible is to think back a hundred years. Do you suppose the wiseheads of 1824 dared risk their necks by predicting any one of the mechanical marvels we think commonplace today?

But coming back to the near future, I think we can safely say that the open car, as we know it today, will be discarded. Every car built probably will have some form of convertible body, making it a simple matter to open it or close it, depending upon the weather. Disappearing windows, doors, and side panels to convert the body already are on the way.

The demand for cheap, quick transportation probably is going to mean the building of vehicles that are a cross between the motorcycle and the automobile—perhaps little three-wheelers with light, smooth-running engines. Such cars will be most economical to buy and to run, and very easy to manipulate in traffic. They will be little one-seaters—or two-seaters at the most—perhaps with inclosed bodies to make them independent of weather. They are a needed utility, and they are undoubtedly right ahead.

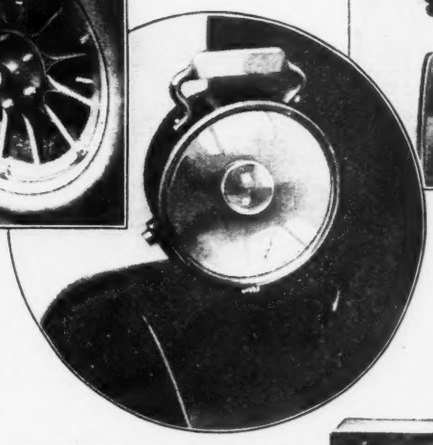
Next month—How to eliminate carbon and save trouble, fuel, and repair bills in running your car.


VENTILATORS TO CLOSE OR OPEN
UNBREAKABLE GLASS FOR ALL WINDOWS
GEARSHIFT MADE UNNECESSARY BY 48-CYLINDER MOTOR
LICENSE PLATE LIT UP
R-5×76
AIR FILTER
SELF-STABILIZING FRONT WHEEL
EXTRA LARGE BALLOON TIRES
LOUDSPEAKER
RADIO SET
TWO WHEELS IN REAR
DISAPPEARING STEP
RUBBER OR AIR CUSHION AROUND CAR TO INSURE AGAINST DAMAGE BY COLLISION
JACKS ATTACHED TO FRAME AND OPERATED FROM DRIVER'S SEAT
PAUL

Our artist's conception of the motor-car of 1950, based on Mr. Spencer's interesting forecasts—A three-wheeled cross between the automobile and motorcycle, combining economy, comfort, and ease of operation, with a light, smooth-running engine of many cylinders, requiring no gearshifts. Important improvements are indicated

New Inventions for Your Car

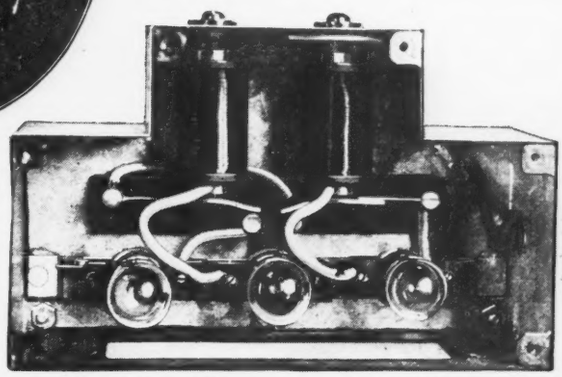
This new rear fender light (below), with concealed wire reel, throws a beam of light on the edge of the road, and (at left) can be detached if desired



This gas cap for Ford tanks has a spring-hinged center. The hose nozzle is pushed through the cap, which closes automatically when the nozzle is withdrawn

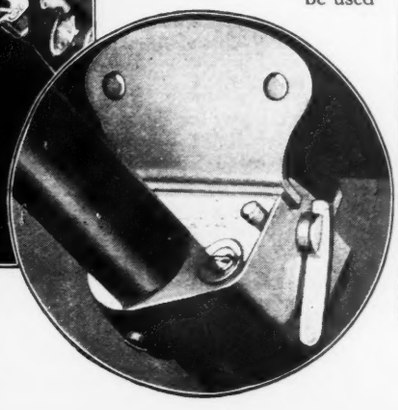
©U. & U.

Rear-seat passengers in open cars are given windshield protection by this collapsible device, which weighs only a few ounces

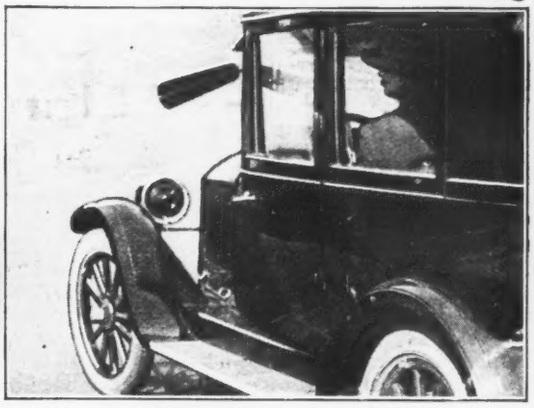


This triple tail light cannot go out. When one bulb fails, another lights. Each is controlled by an electromagnet that automatically transfers the current to the next as its bulb burns out. The bulbs light singly

In this auto lock, ignition wires pass through a box with eight knobs, each controlling the wiring to one cylinder. Four, six or eight can be used



A new theftproof auto lock combines an ignition lock, steering-wheel lock, and steering-column bracket. It is situated on the steering-post of the automobile, where it enters the dash



This semaphore for closed cars enables the driver to signal without lowering a window. It is of metal, painted red, mounted on the windshield

Keeping Your Car in Good Order

Money-Saving Ideas for Auto Owners

STALLING of motor horns is one of the annoying troubles of autoists and it always occurs, of course, in the thickest traffic. Frequently it is due to the fact that the brushes do not make very good contact—a difficulty that can be eliminated very easily by the method shown in Fig. 1.

The new brush springs are made from cut-off safety-pins. Leads to the field coils of the horn motor are connected with the loops of the pins by short screws and nuts. The brush holders are slotted with a hacksaw to receive the new springs and the ends of the cut-off pins are bent over for about 1/16 in. of their length.

Since the safety-pins have more spring than the usual small springs that come with such a horn, the brush pressure is much greater and a good contact is assured.

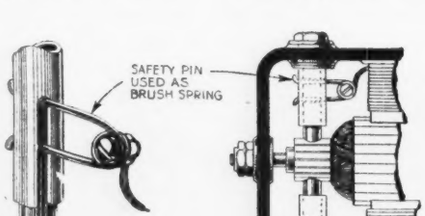


Fig. 1. Safety-pin repairs horn motor

VARIOUS kinds of short-circuit troubles are experienced in automobiles because the insulation of the wiring has been worn through by chafing against metal edges. Much of this wear can be overcome by running the wires through strong, homemade conduits, as in Fig. 2.

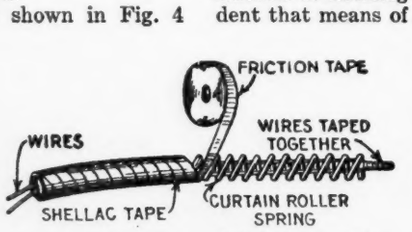


Fig. 2. Emergency conduit for automobile wires made from window-shade springs and tape

Procure an old curtain - roller spring and stretch it to suit the length of wires. Wrap the wires with friction-tape. Run them through the spring, then wrap the spring closely with friction-tape, making laps of not more than ¼ in., being sure that each lap is well stuck to the one before. When the spring is fully wound, give the whole a coat of shellac.

Fig. 3. Grease cups hold repair compounds

THE advantages of large grease cups as containers for valve grinding and soldering compounds will be apparent to the mechanic. Such containers may be stowed in the toolkit, without the usual annoyance of the materials' escaping, as so often happens when they are kept in their original tins.

Select grease cups of slightly different size, or one cup of brass and another of steel, for the different compounds, so that they can be distinguished readily. Better still, stencil the top to identify the contents.

In the stem of each of the containers, tap a small thread for the insertion of a knurled thumbscrew, as is shown in Fig. 3. It is necessary only to screw down the cap of the container to release the compound—a quick, convenient, and economical method. Containers of this kind are especially useful to the auto-camper.

AS EVERY car-owner knows, the oil in the crankcase of an automobile should be changed about every thousand miles or so if long engine life is to be expected. However, it is not always easy to remember just when you did change the oil last unless you reinforce your memory with some sort of record.

The simple counter shown in Fig. 4 serves the purpose admirably and costs nothing to make, as it is built out of five old wooden checkers, a few leather washers, and a piece of heavy tin or sheet brass. The numbers on the checkers are cut from an old calendar and fastened on with glue. A long screw with a butterfly-nut serves both as an axle and as a clamping screw.

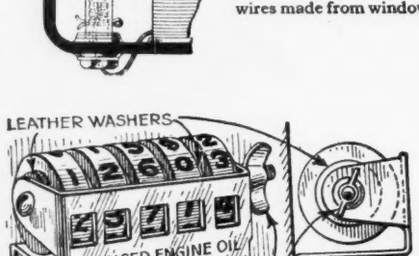


Fig. 4. Oiling record for garage made from checkers, leather washers, and odds and ends

Fasten the counter to the wall of your garage and when the oil in the crankcase is changed, set the recorder to correspond with the speedometer reading. Then you will know at any time just how far your car has gone since new oil was put in.

THE valve-seat reamer shown in Fig. 5 is made so that it can be used in different engines. The feature is the stem or pilot, which is interchangeable. About three stems are necessary with diameters 5/16 in., ⅜ in., and 7/16 in. respectively. The handle and stems are made of machine steel and the cutter is tool steel, hardened. A tool like this is less expensive than three or more reamers and will take care of the average job that comes into the auto-repair shop.

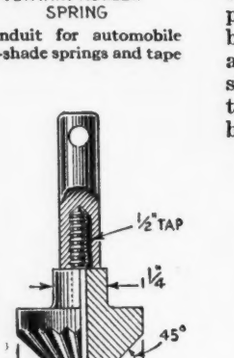


Fig. 5. Reamer with interchangeable pilots

ONE detail of the car that is difficult to silence, especially on trucks, is the hood. When one considers the ordinary method of hooking these down, it is evident that means of compensating for the wear are not provided.

When the original fabric strips inserted in the ledges where the hood is seated have given way, they may be replaced with leather book straps, which are laced into the slits (Fig. 6) after the buckles have been removed.

Where the hood seats on the car frame ledges, a side movement frequently will make a disagreeable rattle. A method to prevent this also is shown in Fig. 6. Rubber pads made from short lengths of rubber tube are carried around the ledges.

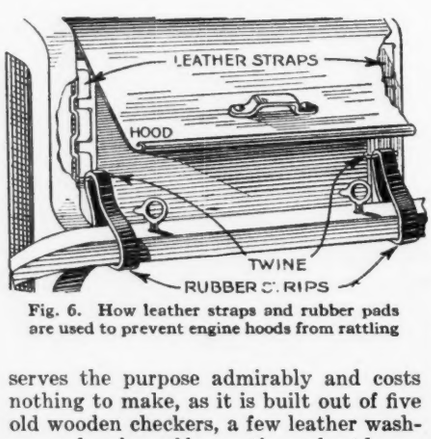
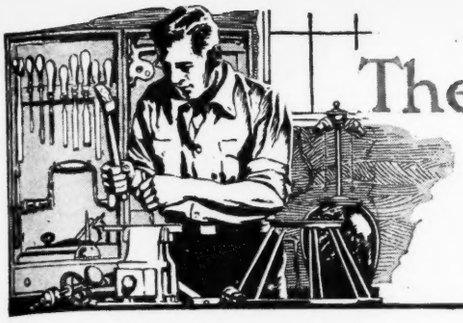


Fig. 6. How leather straps and rubber pads are used to prevent engine hoods from rattling

WHEN relining four-wheel brakes, it is desirable to renew the linings of all the brakes at the same time, using the same grade of material, so that the identical thickness of lining will permit of more uniformity in the adjustment.

The front wheels should be pointed directly ahead while adjustments are being made, for the reason that most of the brakes are constructed to release the outside wheel when turned either to right or left. Adjust all the bands so that they are uniformly tight, testing by slightly releasing the pressure on the pedal.

It is contended by some designers that the rear brakes of the car should grip more solidly than the front in order to lessen interference with steering. However, the construction that frees one front wheel when turning right or left normally meets all needs in steering with the brakes locked. Any adjustment to make the front brakes less effective than the rear would be difficult for the average owner or garageman to make and possibly might result in the front brakes' not coming into action.



The Home Workshop

Arthur Wakeling, Editor

Your Tools and Their Care

By Albert S. Peacock

Shop Superintendent, New York University; Consulting Expert on Tools, Popular Science Institute of Standards

"WHY don't you use a file, Jim?"

"File? What do you mean? I am sharpening this plane iron."

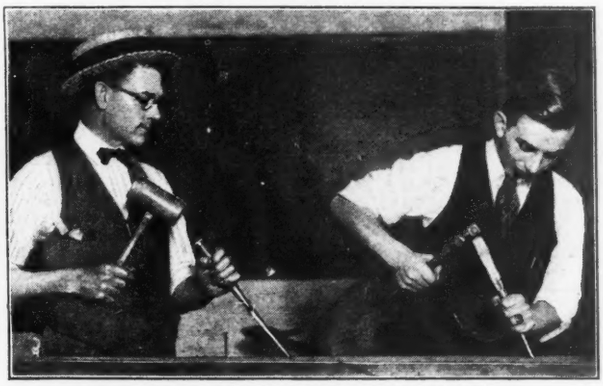
"Oh! I thought you were trying to dig a groove into that stone you have there," said Old Prentiss in a voice and with a smile that savored strongly of sarcasm.

Old Prentiss had charge of the shop where I learned to know my friends, the tools. Jim was one of us—the gang—and had the makings of a good mechanic, but there were too many rough edges. One of them was about to be knocked off by Old Prentiss, and I sidled closer to hear what he had to say.

"Now, listen," the old fox continued. "Let's see if we can apply common sense to this proposition, as we ought to apply it to everything we do. There are very few of us who can run our arms or our bodies back and forth in a perfectly straight line—I mean so that we can move a plane iron, a chisel, a knife, or any other tool straight back and forth across an oilstone and keep the tool from rocking. I know you may have heard that that is the way, but let me tell you, 40 years at a game of this sort give a fellow a pretty fair notion of the best way to do a job; and the way you are doing it isn't my notion of the right way.

"Instead of getting a straight bevel on the tool, you are likely to rock it a bit and give it a convex surface. Of course, that doesn't give the edge the proper shape.

"Then, too, it stands to reason that you are going to dig a hollow into the stone. You've seen the one I have; I've been using it for seven years and have not had it refaced. Still, there's not a single, solitary groove in it. Why? Because I move my tools in circles over the surface, covering the entire area. It isn't so hard then to keep the bevel straight, and by moving in small circles I also avoid gouging the stone.



Correct method of driving a socket chisel (at left), as compared with misuse of a paring chisel (at right)

"Another thing—I notice that you seem to exert as much or even greater pressure on the backward stroke as on the forward stroke. What's that going to do for you? It will turn off a heavy feather edge, and it'll be some little job for you to remove the feather edge and put a razor edge on the tool.

"Bear down on the forward stroke and you will cut against the edge, keeping the feather at a minimum and yet cutting sufficiently to give you a keen, sharp edge. Of course, you'll turn off a slight feather, but that can be removed by giving it a stroke on the back, pushing the blade away from you and holding it perfectly flat on the stone. Then give one stroke on the bevel, another on the back, and so on until the feather has worn off."

At this point Old Prentiss saw me over by one of the lathes with my head tilted at such an angle that he knew I was "listening in." He took that as an invitation to launch into his pet subject—"the use and abuse of tools." It was not a very busy morning, so he invited me over to hear what he had to say.

"Now, you young fellows know as well as I do how difficult it is to do a job when you have no tools. But you might just about as well not have any tools as have poorly kept ones.

"To get back to something I was just telling Jim—what use is an oilstone if it isn't flat? And yet if Jim had continued at the rate he was going, he would soon have his looking dished, like the track in an autodrome!

"You fellows have been with me a year and yet one of you is guilty of putting that very oilstone back on the shelf with all the oil and dirt still on it. I want you always to put back your tools clean and in good condition. It won't do a bit of harm to clean your oilstone occasionally with kerosene. When a chisel has been nicked, don't put it away as it is, for the chances are that the next time you want that very size chisel, you won't have time to grind it up. If you put in a nick, take it out right away. Clean off the tool and put on a thin coat of oil occasionally to keep it from rusting. Don't throw your edged tools into a chest or drawer full of other tools.

"I might say something here on the subject of grinding on a carborundum, or other artificial wheel. You know the speed at which one of these turn, and you know the heat that can be readily developed by them. Be very careful not to draw the temper. I wonder if you know how little heat is required to

(*Continued on page 118*)

Two crimes against tools and a group of casualties. The saw has lost several teeth, the bit has been bent and the point ruined by too much pressure, the try-square blade has been used as a pry, the plane was broken by being dropped, and the other tools were damaged by similar abuse

Lamp-Shades from Wooden Bowls

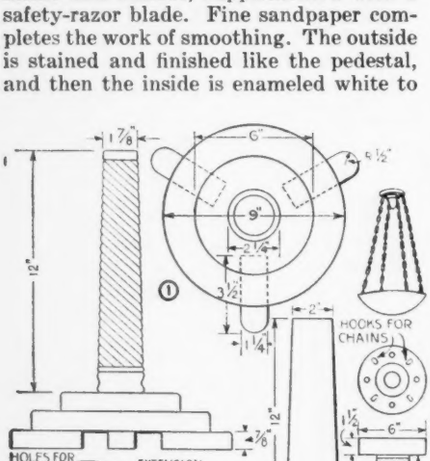
By Gladstone Califf
Superintendent of Schools, Richland, Ia.

HOW to make an attractive shade is a problem to be solved whenever a table lamp is to be constructed in the home workshop. Shades generally are made by covering a wire frame with silk or imitation parchment. Far more unique and even less expensive are shades made as illustrated from wooden chopping-bowls. Such a shade may be ornamented in various ways.

Of the three lamps detailed below, No. 1 is made in the following way: Lay out two circles for the circular members of the base and cut them out with a circle or coping saw, keeping a short distance beyond the line. Smooth the edges with a rasp and sandpaper.

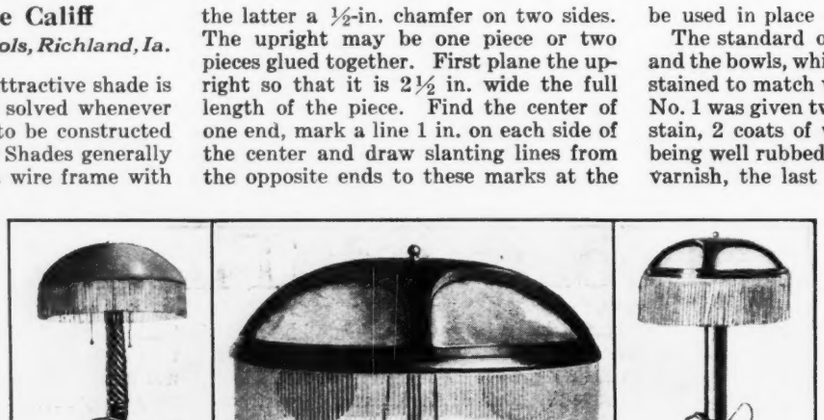
The upright is part of an old table leg, but it can be made by hand by the method described in my article, "Making a 'Turned' Spiral Pedestal," in the April issue of POPULAR SCIENCE MONTHLY. The small base supports are made according to the dimensions indicated. Before assembling the parts with screws and glue, bore a ⅜-in. hole in the uprights for the wiring.

The shade is a wooden chopping-bowl 15 in. in diameter. A steel cabinet scraper is used to remove the rough places, both inside and outside, supplemented with a safety-razor blade. Fine sandpaper completes the work of smoothing. The outside is stained and finished like the pedestal, and then the inside is enameled white to reflect the light. A fringe or beading is attached around the inside of the bowl with small tacks.



Details of two lamp-stands, a chopping-bowl shade, and an indirect-lighting fixture

Lamp No. 2 is even simpler to construct. Make the two square pieces for the base and cut the base supports, giving the latter a ½-in. chamfer on two sides. The upright may be one piece or two pieces glued together. First plane the upright so that it is 2½ in. wide the full length of the piece. Find the center of one end, mark a line 1 in. on each side of the center and draw slanting lines from the opposite ends to these marks at the top. Do this on the opposite side and plane down to the slanting lines. Repeat the operation on the remaining sides in order to complete the taper. Drill a ⅜-in. hole through the upright for wiring.



Lamp No. 1 is shown at left, No. 2 at right, and No. 3 in the center

The upright for lamp No. 3 was made from a discarded pedestal. It would be a simple matter to turn a similar stand if a lathe is available, and, lacking this, it costs very little to have a turning made. The base is 10 in. in diameter, with a ½-in. chamfer around the edge, and the four base supports are chamfered in the same way.

The shades for lamps Nos. 2 and 3 are pierced chopping-bowls. First find the center of the bowl and draw two lines through it as indicated in the accompanying drawing. With a compass describe the four arcs shown. Then, to allow the insertion of a coping-saw blade, bore three ½-in. holes in each of the four places to be cut out. Make the saw kerf or cut a slight distance from the line and smooth it with a rasp and sandpaper. The cut edges may be beveled, rounded, or molded to give the shade a lighter appearance, if the maker wishes to go to that trouble. Scrape and sand the bowl inside and outside, as in the case of lamp No. 1.

THE shades shown are lined with a double thickness of old-rose silk. This is done by cutting a paper pattern to fit half the inside of the shade and using this as a guide in cutting the silk. The lining is held in place with thumb-tacks and a strip of tape made of the same silk is sewed over the tacks. The tacks may be cut a trifle short, as the wood is hard. Parchment or oiled water-color paper may be used in place of the silk, if preferred.

The standard of each lamp is walnut, and the bowls, which are maple, have been stained to match with water stain. Lamp No. 1 was given two coats of walnut water stain, 2 coats of white shellac, each coat being well rubbed, and then finished with varnish, the last coats well rubbed with pumice-stone and oil. The other two lamps were stained and finished by French polishing.

Another use for a chopping-bowl is to form a shade for an indirect light, as shown at the right hand of the accompanying drawing. The bowl is finished in the same manner as that of lamp No. 1 and the ceiling plate is constructed as shown and finished to match the bowl. The brass chains are fastened to hooks on the inside of the bowl and hung from hooks in the ceiling plate. The electric wires run through the ceiling plate and down alongside one of the chains to the light, which is in the bottom of the bowl.

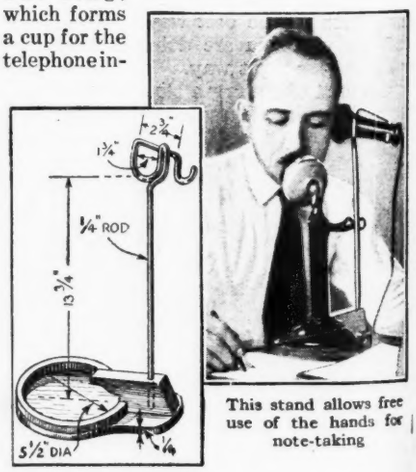
A good finish for such a bowl is simply three coats of orange shellac, rubbed between coats, and several coats of thin wax.

Hardware and electric fittings for the lamps can be purchased in any electric supply store. These lamp fittings have a brass rod that supports the shade; the upper part of this rod projects through the shade, which is held in place by a brass nut. Each lamp has two pull-chain sockets. If desired, silk cord may be used to lengthen the chains.

Stand Holds Telephone Receiver while in Use

TO ALLOW free use of both hands while telephoning is the purpose of the inconspicuous stand illustrated.

Glued to the wooden base is a sawed-out ring, which forms a cup for the telephone instrument. A block shaped as shown holds the telephone in place without any screws, and this piece also supports a rod, preferably of ¼-in. aluminum wire, bent to hold the receiver.—J. G.



This stand allows free use of the hands for note-taking

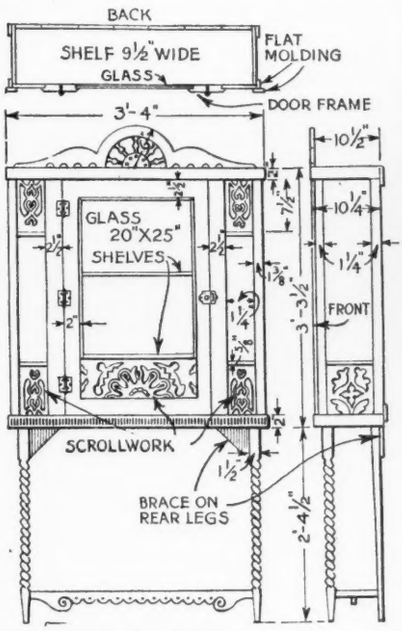
"Antique" Cabinet Cheaply Built

By Rufus E. Deering

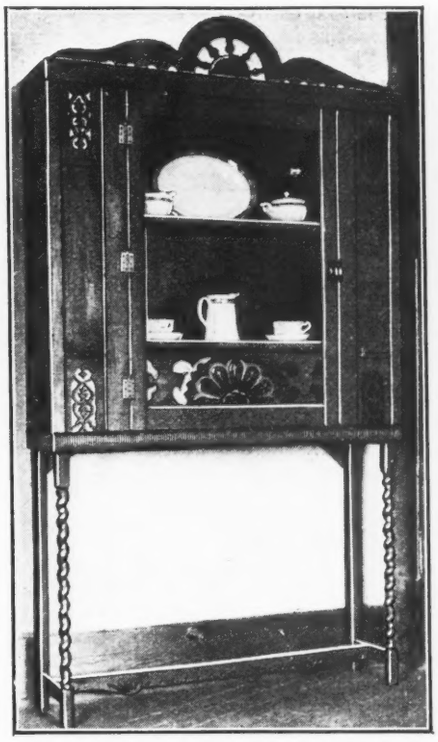
I HAVE just finished the construction of an "antique" china closet from pieces of lumber taken from an old reed organ.

Old reed organs may be obtained cheaply from music dealers, yet they contain beautiful lumber, usually solid walnut or solid oak. There are many fine turnings and moldings on them that cannot be had in any other way without considerable expense. The lumber is well seasoned, often more than 50 years old, and it has been used just enough to make it suitable for developing the "antique look" now so highly esteemed.

The two-tone effect at present in vogue can be duplicated by covering portions of the panels in the cupboard with panels of scrollwork taken from the old organ. The cupboard panel is finished first in one tone; then the scrollwork is placed over it and finished in another tone. The scrollwork is fastened on by gluing it lightly on the back and nailing it in place with brads sunk with a nailset.



Beautiful aged oak from an obsolete reed organ furnished most of the material for this antique looking china closet. The ornamental top, scrollwork and molding were taken from the organ; the front legs were made by hand as described in the July issue



As the cupboard was put together, the old varnish was removed from each piece with cabinet scrapers, glass, steel wool, knives, and sandpaper. The wood was stained before varnishing, but it was not necessary to use a filler as the surface was quite smooth with the original filling.

The back of the cupboard was made by placing rails with grooves at the top and bottom. The ends of the back boards rest in these grooves.

The frame for the door was adapted from a panel frame of the organ. The lower part of the door was paneled over so that the dishes on the lowest shelf of the cupboard would not be visible. The bulk of the dishes are stored here out of sight, and the two top shelves left for the prettier dishes and glass.

The legs were made of straight pieces of stock 30 in. long and 1½ in. square. The two front legs were made in a spiral shape by a method of hand turning described on page 73 of the July issue of POPULAR SCIENCE MONTHLY. The two back legs were tapered slightly toward the bottom.

To fasten the legs, they were allowed to extend up in the corners of the cupboard and were screwed securely. The two back legs then were braced with three-cornered pieces to the back of the cupboard.

The ornamental top and moldings were adapted from the organ material as shown, but this feature could be varied in many ways, according to the material on hand. The moldings were all simple flat moldings 1¼ or 1½ in. wide. The wood was given a shellac-wax finish.

The whole cupboard, of course, might be built of new lumber, but it would be harder to give it the antique look that is so valuable in a piece of furniture like this.

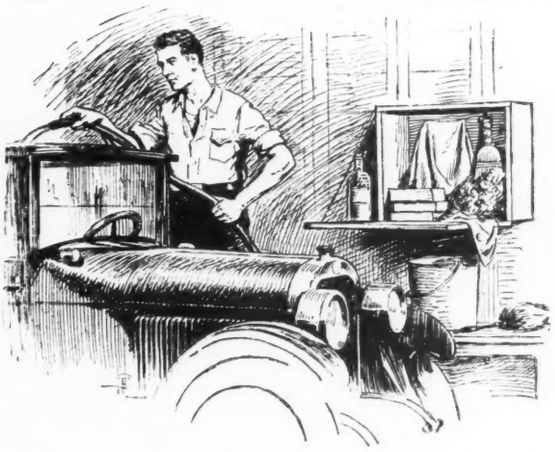
How to Keep Your Automobile Polished

By George A. Luers
Automotive Engineer

WHEN the garage door swung open and Jackson's car rolled into the alley, the paint glistened in the sunlight. Any one who did not know the car would have said it had just come from the paint shop. Those who knew Jackson and his car, however, were aware that the machine was three years old and never had been repainted.

The difference in the appearance of similar cars after a year or more of service is so pronounced that every owner must appreciate the need of proper care and treatment to maintain the original gloss and luster. Jackson had given his car the requisite attention.

Normally, there are two natural elements ruinous to the paint: Exposure to the heat and bleaching of bright sunshine, and the solvent action of rain and snow. One human element also enters into the rapid destruction of the painted surface—



the tendency of the owner to wipe off the varnish with any available rag, regardless of grit, grime, or grease.

To avoid these requires only a little care. Follow Jackson's example and do not park your car day and night in the open street, or clean it with any old cloth.

The paint is a film little more than .02 in. thick. The upper surface, which is a varnish or special lacquer, is a hard film and takes a high gloss. This film must be kept intact in order that the color paint underneath will be protected and retain its brilliancy.

The equipment to care for the paint and also the top and upholstery is as follows:

2½-gal. wash pail	Cheese-cloth
Castile soap	Sponge
Chamois	Whisk-broom
Wool duster	Body polish

Probably most car owners have these materials on hand, but it is necessary to understand their proper use to obtain the most desirable results.

Rubbing the body should never be done before it has been dusted off with the woolen duster to remove every particle of grit. Hosing mud off the body preferably should be done by flushing and not with the force of the hose. Another method

(*Continued on page 102*)

Constructing a Six-Inch Jointer

By Frank N. Coakley

IN DESIGNING machinery for the home workshop two points must be borne in mind. One is that the machine should be as strong as its manufactured brother; the other is that easily obtainable stock should be used as far as possible, to avoid the cost of having patterns made for castings.

Both these requirements I have tried to observe in designing the 6-in. jointer for the home workshop shown in the accompanying drawings. The entire machine is made of oak or other hard wood and standard parts that may be purchased at hardware stores and from dealers in machinery. Even the scrap pile or junk yard may yield some necessary parts. These sources of supply I can safely leave to the ingenious builder.

The side members of the jointer are made from oak plank 2½ in. thick and of the width and length shown in the side view. Pains should be taken to give the various pieces a good finish wherever they fit together, and the holes that are to be used for bolts should be drilled smaller than the bolts. That is to say, the holes for the 9/16-in. bolts are to be ½ in. in diameter so that the bolt can be driven through, making a tight fit. A heavy washer of good size is to be placed between the wood and the nut wherever they come together to prevent the nut from digging into the wood.

THE countershaft for driving the cutter is fastened directly to the bottom members. The bearings are standard 1⅜-in. bore by 2⅝ or 2¾ in. long, securely bolted to the bottom members. Each bearing is provided with a grease cup.

The size of pulleys and other dimensions not mentioned hereafter will be found in the drawing. Care is to be taken that all the bearings are in perfect alinement, which is always most important.

The tables are made from steel plate perfectly level and smooth. To the bottom of these plates are riveted 2½ by 2½ by ¼ in. angles, the rivets being countersunk on the upper side of the plate and smoothed off carefully. To the sides of these angles the wooden wedges are fastened with oval head wood bolts, the nuts being on the inside against the angles.

The bottom wedges are bolted securely to the stationary members. This allows

Most of the labor of hand planing is eliminated by using a bench jointer

wingnuts for clamping the table in position, two being used for each table. Between the two side members two separators are used for holding them in line and four 9/16-in. bolts serve for clamping.

For the adjustment of the end table at the entering end of the machine, reference should be made to detail *A*. The separator just mentioned is used as a support for the flat bar, which is tapped to receive the adjusting screw. A 2 by 2 in. angle is riveted to the top plate and the hole for the adjusting screw is oblong or oval to allow the screw to move when the table is being raised or lowered. This adjusting screw is not shown for the delivery end, as it is seldom that this table is changed, but if it is thought advisable to put one on, the same material and method may be used.

The fence is made from ¼-in. steel plate 2 in. wide and 14 in. long. The adjustment is obtained by using two 2 by 2 by ¼ in. angles as brackets, both being provided with holes at the bottom so that they serve as a hinge. One angle is riveted to the fence and the other is clamped to the table with standard thumb-nuts. A slotted hole is provided to allow the fence to slide back and forth, as indicated in detail *E*. The three holes in the bottom angle will give settings for two angles—22½ degrees and 45 degrees. Others may be provided by drilling holes in the necessary locations.

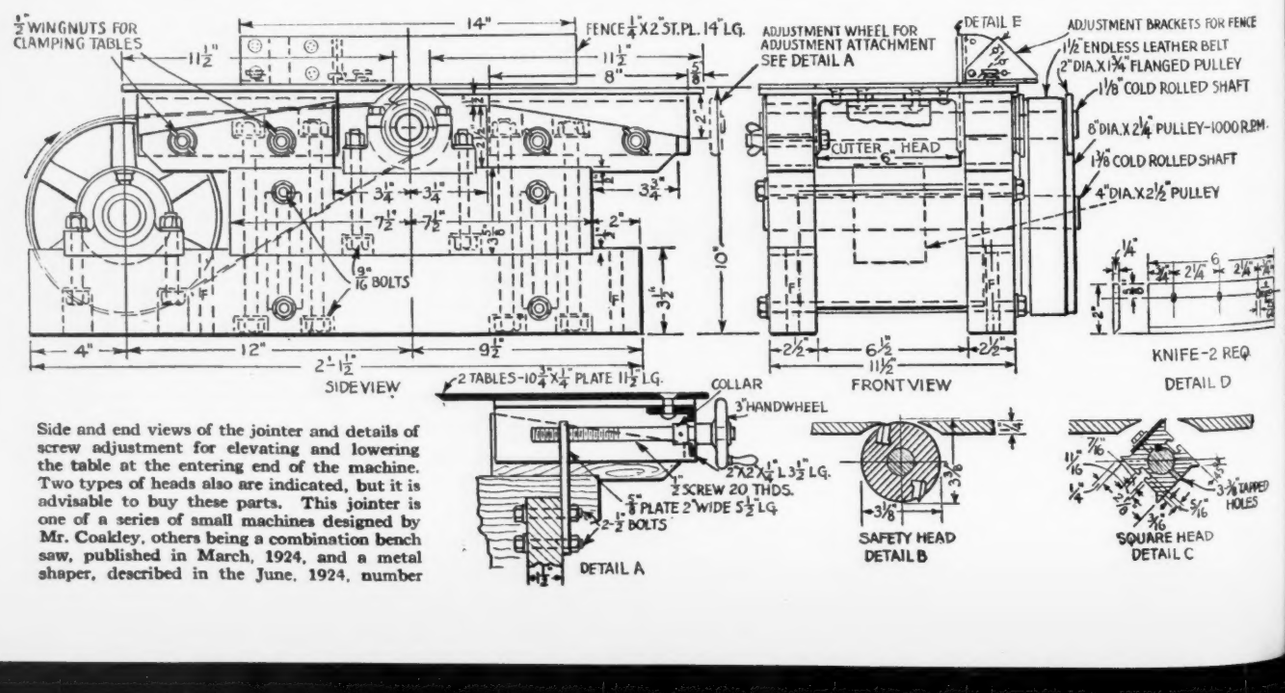
The two bearings for the cutter head are standard bearings for a 1⅛-in. shaft. It is advisable to use bearings with removable bearing caps, as it may be necessary at times to remove the head.

Two styles of heads may be used, one known as the safety head, shown at *B*, and the older style of square head, at *C*. The builder will find either satisfactory and should select the one he is best equipped to make, no doubt that shown at *C*. It is to be remembered, however, that in many shops the old-fashioned square head has been replaced by the safety head, as in case of an accident the latter cannot do more than take off a small slice from one's fingers, whereas the square head has been responsible for many serious accidents.

IF ONE doesn't care to make the safety head, yet wishes to use one, it can be bought at a low price. This is, perhaps, advisable, because it is necessary to have this part of the machine run true and be in perfect balance. The head either may be keyed or fastened to the shaft with setscrews. If keyed, two short keys may be used—one driven from each end. They need not be larger than 3/16 in. square, but must be a good fit. If setscrews are used, four are needed, equally spaced and set slightly into the shaft.

The knives are another part of the machine I should advise one to purchase, not because they cannot be made by the amateur mechanic, but on account of the tempering and grinding. One can pur-

(*Continued on page 112*)



Side and end views of the jointer and details of screw adjustment for elevating and lowering the table at the entering end of the machine. Two types of heads also are indicated, but it is advisable to buy these parts. This jointer is one of a series of small machines designed by Mr. Coakley, others being a combination bench saw, published in March, 1924, and a metal shaper, described in the June, 1924, number

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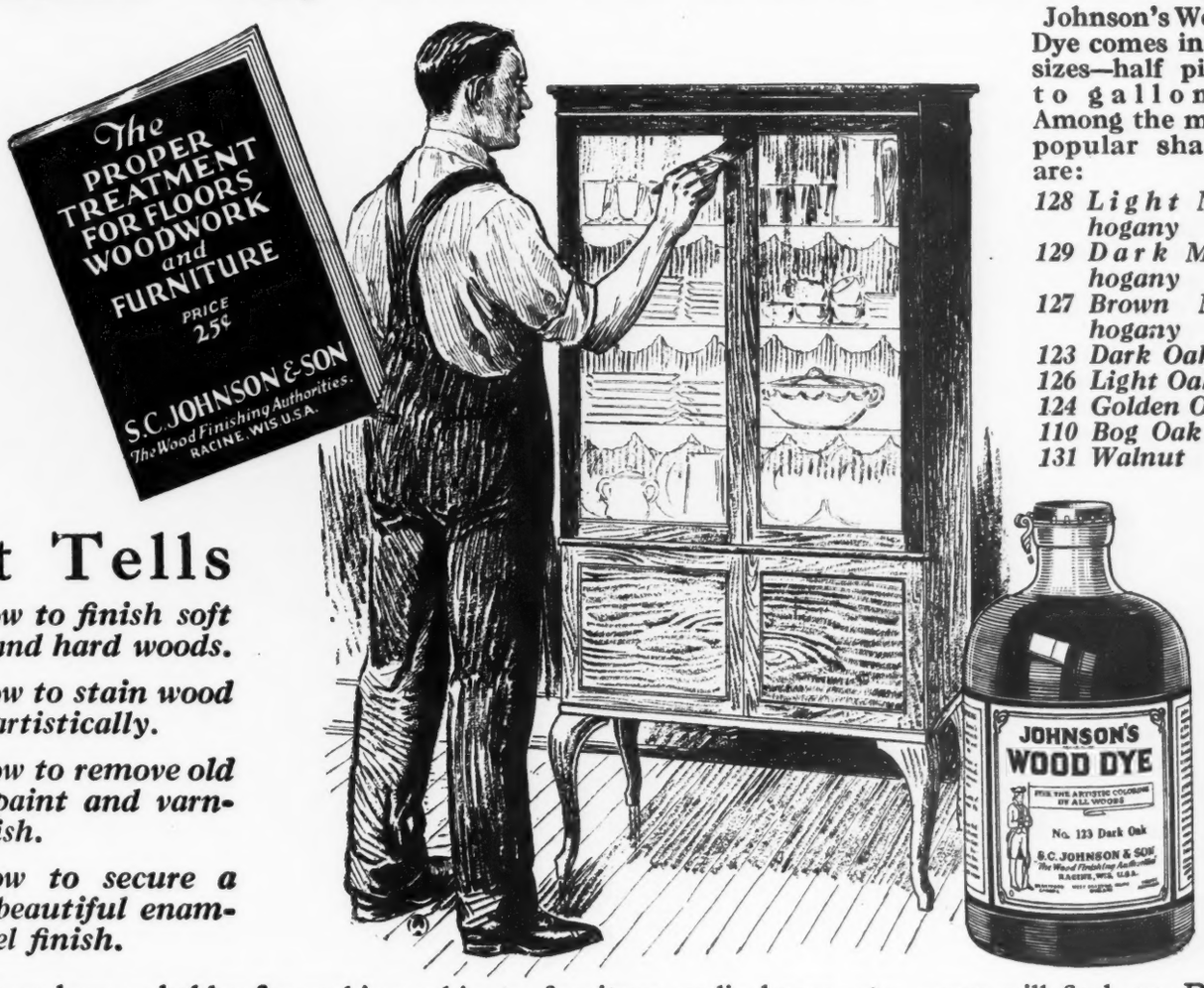
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Better Shop Methods

How Expert Mechanics Save Time and Labor

Making the Most of Your Milling Machine

By Albert A. Dowd
Consulting Engineer

"THERE'S a young fellow over there," said the foreman, "who gets my goat. Every time I give him a new job, he spends 10 or 15 minutes looking at it before he does a tap of work."

The superintendent smiled, as he inquired, "How does he do his work after he does get started?"

"That's the funny part of it," the foreman continued; "he makes better time on most jobs than any of the other milling-machine hands, and for that reason I can't say very much to him. But it certainly does stir me up to see him stand over there by the window and stare at a piece of work as if hypnotized, while his machine stands idle sometimes for half an hour."

"Well, I wouldn't worry about it, as long as he does his work properly," said the superintendent, as he walked briskly away to another department.

He made it a point, on his return in an hour or so, to pass through the milling department again, and noticed that now the young man was busily engaged, and his machine was tearing through a heavy steel forging at a rate that appeared likely to produce results. Out of curiosity, the superintendent looked up a few records in the cost department, and found that the man in question was making more money on piece work than any other operator in the milling department, although his rate was somewhat lower. Why? Just because he thought out his job beforehand and knew just how he was going to do it. He set it up quickly and carried it through to completion rapidly, making no false moves.

Albert A. Dowd

THIS is the first of a series of noteworthy articles written especially for POPULAR SCIENCE MONTHLY by Mr. Dowd, who has a national reputation as an expert on machine-shop practice. His next article is "Machining Troubles."

When you have a single milling job given you by the foreman, it isn't usually the actual cutting of the metal that takes the time, but the finding of angle plates, parallels, clamps, and the like, and setting up the machine ready for the work. Even in high production milling processes, when fixtures are used for holding and locating the work, the setting-up time is an important factor.

In any kind of a milling job you have two problems to consider: First, to locate and hold the work on the table, and second, to machine it according to requirements. Every man who operates a milling machine knows that work must be held very rigidly in order to prevent "chatter." When work comes through a few pieces at a time and must be machined without fixtures, your foreman may offer a suggestion as to the best method of setting up, but it is *up to you to do the work*. If you do a little thinking before starting the job, you will find it a great advantage. You often get some job that appears simple at first glance, yet you may have trouble with it because you have not been careful in the setting up—in other words, because you did not stop to think it out properly beforehand.

I remember very well the first job I had when I started work in an automobile factory in Connecticut a few years ago. The foreman gave me a blueprint of the rod-end shown in Fig. 1 at *A* and told me that there were 60 pieces on which the radius, *B*, was to be milled and that he wanted the entire job by three o'clock that afternoon.

The pieces had been machined and nothing more was

(*Continued on page 94*)

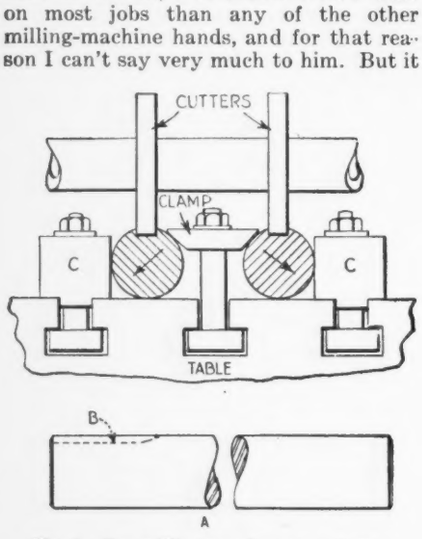


Fig. 2. For milling two keyways at once

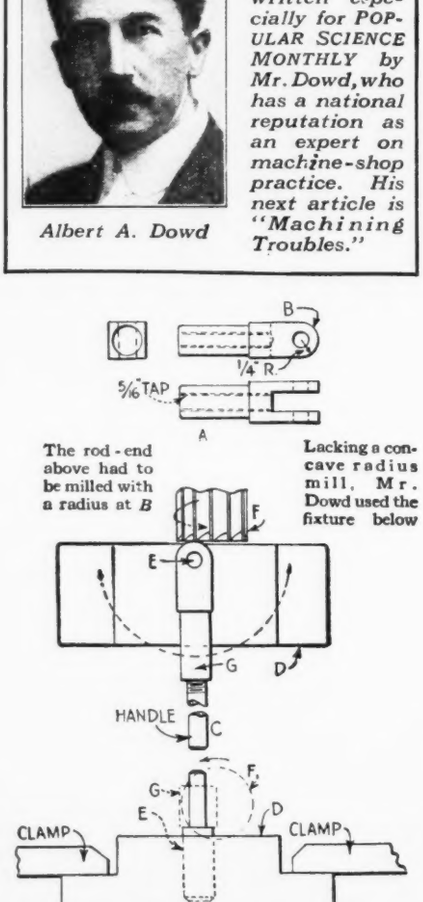


Fig. 1. Radius milling with an end mill

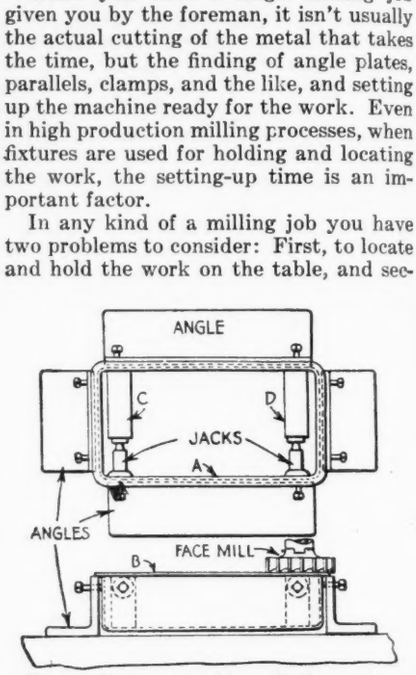
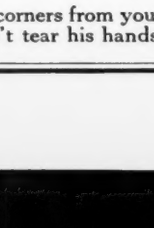


Fig. 3. Supporting thin wall of a casting

Old Bill Says——



WHEN you have many jobs to do, the quickest and easiest way is to do only one at a time.

The fellow who says, "That can't be done," generally wakes up when he sees somebody doing it.

If you want to change your luck, put a "p" in front of it, and keep plugging.

The man who uses a monkey-wrench to hammer a cold chisel doesn't belong in any machine-shop.

I'd rather have my shoulders to the wheel than have my back to the wall.

Almost any one can do the easy work; it takes a good mechanic on the hard jobs.

Don't forget to remove all burrs and sharp corners from your work with a file, so that the other fellow won't tear his hands.

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HOW TO READ AND THE ADJUSTMENT OF MICROMETERS
MILLING AND MILLING MACHINES
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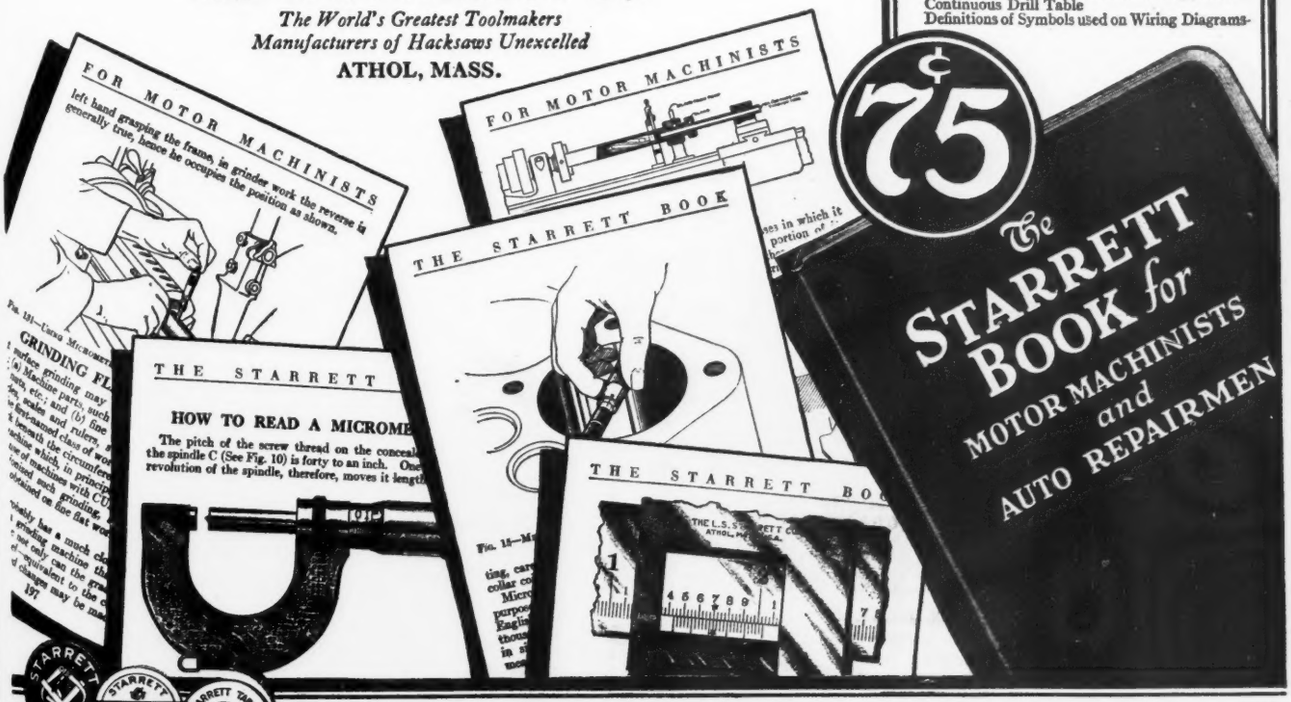
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How to Scrape Metal Surfaces

By H. L. Wheeler
Machine-Shop Foreman

Fig. 1. Spotting work on a surface plate (at left), and a mechanic demonstrating correct position for scraping (at right)

ALL bearing surfaces on high grade machinery must be scraped. We have only to consider the enormous number of machines turned out to realize how vast is the area of metal surfaces scraped each year in machine-shops. For this reason the art of scraping metals is an important branch of the machinist's trade; and it is an art that cannot be learned merely by following set rules. Perfection is acquired only through patient effort and continued practice.

Machined surfaces rarely are absolutely accurate, except, perhaps, work that comes from the grinding machines, and even this, while appearing flawless to the naked eye, is not entirely perfect. Large flat or long parallel surfaces, whether planed or milled, are never quite true when they leave the machine. And where such surfaces are to function as a bearing for some other part of what is to be an accurate piece of mechanism, they must be scraped and the mating part must be scraped to them. This scraping process compensates for the errors left by the machine and incidentally leaves a smooth surface.

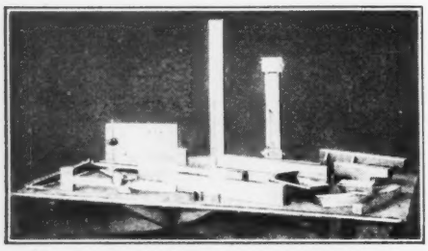


Fig. 2. Parallels and scraped test pieces used in the checking of milling machines

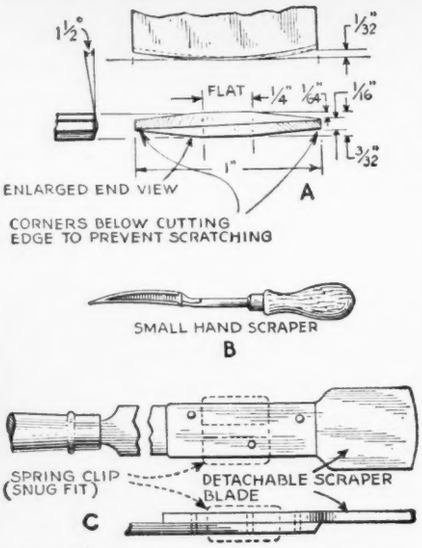


Fig. 3. Convex scraper (exaggerated), a bearing scraper, and a detachable-blade scraper

Several attempts have been made to accomplish this work by mechanical means, but up to the present time, success has not crowned the efforts of inventors in this field. Those who take up scraping as a specialty need have no apprehensions of being crowded out of a job by the development of a machine to do the work. It is one of the few hand operations that still baffles the ingenuity of inventive skill.

In this article I shall describe the few simple tools used and some of the conventional methods employed in the work.

At *A* and *B*, Fig. 3, are shown types of scrapers commonly used, the flat scraper for flat work and the half-round scraper for cylindrical work, such as fitting bearings. These vary in length and width and slightly in shape, depending upon the nature of the work and sometimes the individual fancy of the operator.

Scrapers for flat work usually are made from ¾ to 1¼ in. wide and about 1/16 in. thick at the end or cutting point, tapering slightly for 2 or 3 in. to the heavier section of the body, which is from 3/16 to 5/16 in. thick. The highest grade of carbon-tool steel makes the best scrapers—about 1.40 to 1.50 carbon. They should be almost file hard, or as hard as possible without having a tendency to crack or crumble at the edge. A detachable blade scraper for finishing and light work is shown at *C*. The scraper is fastened to the long shank by means of three pins and a spring clip.

Opinion varies concerning the correct contour or shape for flat scrapers. Hold a machinist's scale at an angle and let the end come in contact with a flat surface. Note how the whole width of the scale bears from corner to corner. Now move the scale a short distance while bearing down on it. The corners have a tendency to drag or scratch, do they not? If a scraper is ground so that the cross section at the cutting end resembles a scale, it inevitably will do the same thing. To get away from this objection, the end is rounded slightly as indicated at *A*.

It will be noticed that this scraper has still another feature that enhances its cutting ability over the strictly flat scraper, which merely is rounded at the end. The cross section at this point is slightly convex. This raises the corners from the surface even when it is held in a horizontal position.

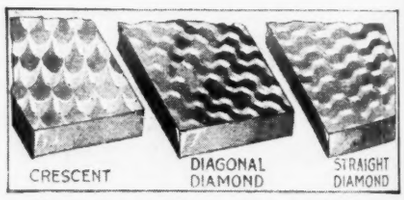
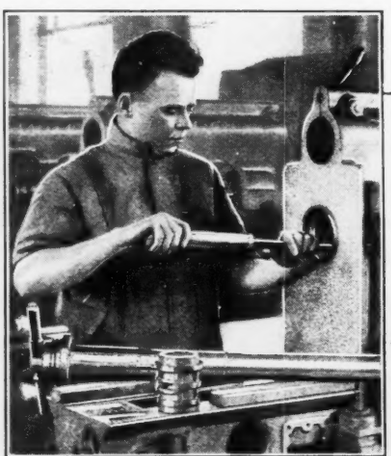


Fig. 4. Types of frosting used to ornament surfaces previously scraped to a true plane

It will be seen that this method of grinding makes it practically impossible for the corners to dig in at any angle. The end is ground diagonally from opposite corners and it is given a slight back rake—about 1½ degrees. This gives to the cutting edge a free shearing action, which increases the speed of the cut and reduces the resistance of the cut on the operator's hands and arms. An examination of the line drawing clearly shows the form for grinding, which may be accomplished to best advantage on a soft, wet grindstone.

It should be emphasized, however, that the convex form is not absolutely essential for a flat scraper. Some may prefer the perfect flat. In making the convex, indeed, it should be very slight, just enough to make the cutting edge in the center with about ¼ in. flat. In the drawing this has been exaggerated for the purpose of illustrating the idea. The center is actually only from

(*Continued on page 86*)



Figures 1, 2, and 5, courtesy Brown & Sharpe

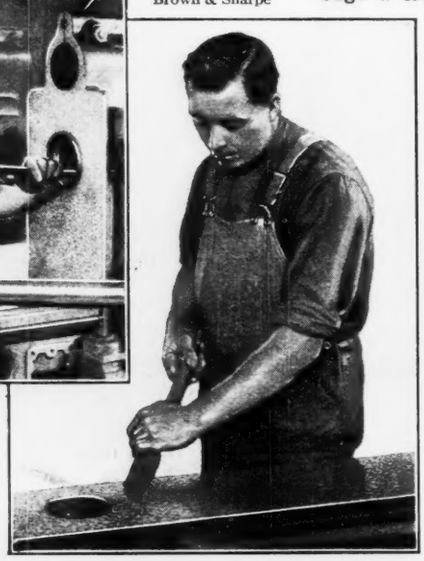


Fig. 5. Scraping a spindle box and the face of a milling-machine column

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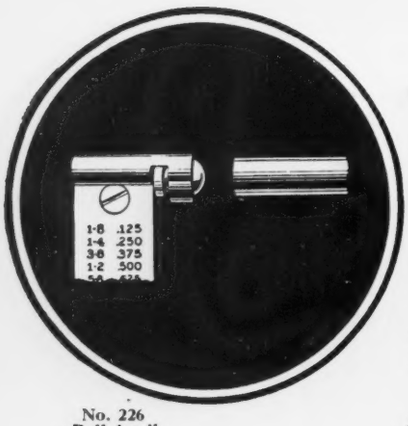

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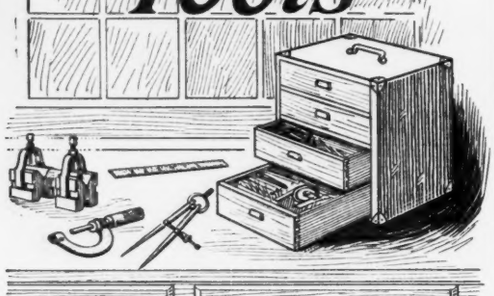

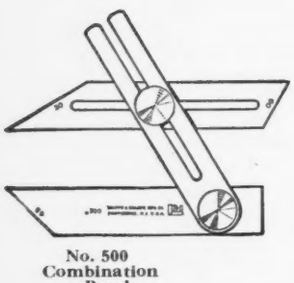

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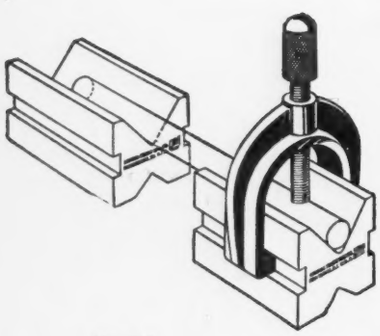

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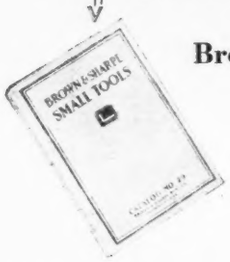

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How to Scrape Metal Surfaces

(Continued from page 84)

.010 to .015 in. higher than the corners. After grinding, the scraper is honed on an oilstone. The oilstone rests on a bench and the scraper, held in a nearly vertical position, is rocked back and forth over the oval edge a few seconds with pressure to give it a keen cutting edge. If the scraper is made of good steel and is properly tempered, it will last a long time without regrinding and only an occasional rubbing on the stone will be needed.

Before scraping a job, the work must be spotted. This operation reveals the true condition of the surface, indicates the high and low spots, and serves to guide the operator. The high spots must be brought down to the same plane as the low spots.

Several different materials are used for spotting. On the coarser grades of work red lead and oil may be used, but for very fine work Prussian blue is the best material. When using Prussian blue, only a very small quantity is required and in all cases it should be used sparingly; a piece the size of a pea will cover a very large area. Another point to bear in mind when applying any spotting material to the plate is that it should be distributed evenly. Thick and thin spots will result in a false bearing.

IN SOME cases the plate is applied to the work and in others the work is applied to the surface plate;. the results in either case are the same. This is governed by the weight of the job. Where the work is of a light character, the usual practice is to apply the piece to the plate.

Before marking or spotting the work, all dirt and chips must be removed and the plate must be free from any dirt or grit. The piece is then placed upon the plate in contact with the surface to be worked upon. It should be moved around and turned in several directions on the plate without applying any downward pressure other than the weight of the piece, as in Fig. 1 at the left. At the right of that illustrated is shown the correct position of the mechanic and the method of holding the scraper.

Considerable pressure sometimes is required on the scraper to bring a job down to the proper surface within a reasonable time; this depends in some degree on the size of the job and the condition of the surface as left by the machine. It is understood, of course, that the push stroke is what takes the metal off the high spots.

In some classes of work, such as scraping long machine beds and the ways of lathes and planers, there is a peculiar freakish tendency of the castings to warp and twist after being machined. It is the custom of some companies to rough off a number of castings and pile them out of doors for several months for "seasoning." This relieves the stresses and strains. Even with this careful process there is often a slight warp or twist in the casting when it comes to the scraper and this has to be taken out with a heavy scraper and lots of elbow grease.

Extra heavy work is set up on the floor (Fig. 5). The surface plate should be

(Continued on page 88)

All out-doors invites your Kodak

Autographic Kodaks *$6.50 up*

Eastman Kodak Company, Rochester, N. Y. *The Kodak City*

6 reasons why Remington Portable

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We believe we make the best typewriter ribbon in the world—and its name is PARAGON

Durability and Reliability

The Remington Portable has won the endorsement of the world by its unequaled durability and reliability. You can count on it for years and years of faithful service.

Compactness and Portability

The Remington Portable is the most compact of all writing machines. When encased it is only 4 inches high, so it can be tucked away in a desk drawer or bookcase. It weighs but 11 pounds. It carries its table on its back, which makes writing easy and convenient in any place or position, even on your lap.

Four-row Standard Keyboard

For fifty years the four-bank keyboard has been recognized as standard. The Remington Portable has always had the standard keyboard, with four rows of keys—no shifting for figures—exactly like the big machines—the keyboard universally adopted by business as the best.

Keyboards in thirty-two languages and for every occupational requirement.

Ease of Operation

You will be surprised how quickly you can master the operation of the Remington Portable. The four-row, standard keyboard, and the simplicity in design and construction of the entire machine make it incomparably easy to learn and to operate.

Beautiful Work Always

The writing of the Remington Portable is exceptionally beautiful. Even a beginner turns out work that is a revelation. This, of course, is due to the fine construction of the machine, and its habit of always being in perfect alignment.

Universal Service

Wherever language is written—on the six continents—you will find Remington service, for there are over 400 Remington offices throughout the civilized world. A Remington Portable owner knows that wherever he goes Remington service is near at hand. This feature is one that no portable typewriter buyer can afford to overlook.

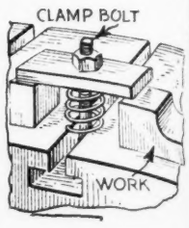
* * *

On every count—whether work, wear or service—the superiority of the Remington Portable is decisive. Sold by over 5,000 dealers and Remington branches everywhere. You can buy one on easy terms, if you wish.

Write for our illustrated, "For You—For Everybody." Address Dept. 67.

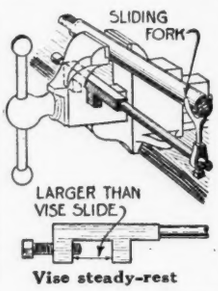
Springs Save Time in Clamping Duplicate Parts

THE simple expedient of using springs under work clamps, as illustrated, has resulted in cutting down materially, in one shop, the time of setting up repetition work on planers. — A. L.



Support Steadies Long Work in Machinist's Vise

WHEN working on long material at the vise, it is often a considerable aid to use a support made as shown. This is machined from a piece of flat stock of the desired length, one end being turned down to any suitable diameter and fitted with a sliding fork or rest. In this way the end of the work may be prevented from sagging. This saves shifting the stock in the vise so often.—F. N. C.



Vise steady-rest

How to Scrape Metal Surfaces

(*Continued from page 86*)

placed at a convenient height for the operator to use or hung on a chain hoist by a special grapple hook. When the plate is rested face down on a bench, it never should rest directly on its finished surface. A special board having leather or felt pads should be provided, or it may rest on another surface plate, face to face.

Scraping bearings also is illustrated in Fig. 5. In this work the interior surface of the bearing is scraped to fit the spindle. Sometimes a special mandrel is made and used as a master plate and in others the spindle is used directly for the bearing for which it is intended.

In Fig. 2 is a group of special test pieces and parallels used for checking scraped angular surfaces, such as the ways of lathes and milling machines and the V's of planers.

Closely allied to the scraping of metal surfaces is the producing of the ornamental appearance known as frosting. This is an added refinement used when time and expense warrant in order to decorate the surfaces. The principal figures seen on frosted machine surfaces are indicated in Fig. 4.

The crescent pattern sometimes is varied by adding a second series of crescents, so that the surface is mottled with what appear to be full circular marks. In either case, the scraper is oscillated right across the surface to form a whole string of crescents at one time.

In forming the straight and diagonal diamond patterns, the mechanic draws the scraper toward him to make one broad mark and then passes it sideways to the right a trifle, preparatory to drawing forward again. To learn to do this is mainly a matter of practice.

It Will

Bring In Stations You Never Heard Before

REACHING out through the ether—"fishing" for new stations in far away places—is a most thrilling game. To many, it's more than half the fun of radio receiving.

Success in this absorbing venture requires not only a good receiver but a headset capable of responding to faint signals clearly and distinctly. Such is the new supersensitive Music Master Headset. "It's equal to another stage of radio frequency," one user said.

The Music Master Headset is to other head phones what the Music Master Reproducer is to other loud speakers—because it is a precision instrument of the highest order.

Cores are of specially selected steel, chemically treated to rust proof them. Pole faces are ground to an accuracy of one-ten-thousandth of an inch of each other; and the specially treated steel diaphragm is gauged to a half-thousandth of an inch. All parts are accurately measured by the most delicate recording instruments known to science. Each finished pair must vibrate fully, freely, evenly and without rattle over the entire scale of audible frequency.

And it is a handsome, comfortable set, sanitary and enduring. Price—$12.

Music Master is the musical instrument of radio. Volume without distortion. Connect as you would headphones. No batteries required, no adjustments. 14-inch model for the home—$30. 21-inch model for concerts and dancing—$35.

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Music Master Corporation

Makers and Distributors of High-Grade Radio Apparatus

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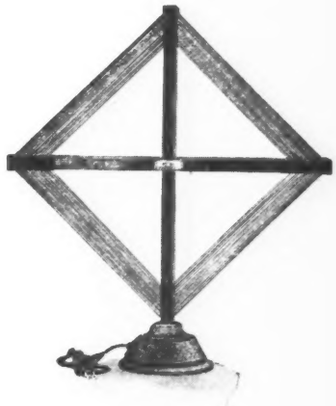
Chicago PHILADELPHIA *Pittsburgh*

Music Master HEADSET



Music Master Loop Aerial is equipped with calibrated dial; covers the entire band of broadcasting wave lengths. Price—$10.

Bench Vise
No. 161
Price, $2.40

A small vise—

with jaws like a bulldog's

A VISE is judged by its jaws. They're "the works." Find a vise with jaws that meet flush and true, won't wobble or loosen, hold with equal strength at all points and with the tenacity of a bulldog—and you've found a vise that will be a real helper for all the years to come.

This Goodell-Pratt Vise is that kind.

Clamps to any bench of less than 1½-inch thickness. Operated by an accurately cut steel feed screw. The two steel guide rods hold the jaws rigid.

All parts carefully fitted—the final operation being the close machining of the jaws to make them meet with absolute accuracy.

Steel parts are polished. Iron parts beautifully finished with enamel, baked on.

Width of jaws, 2 inches; jaws open, 2 inches; weight, 3⅜ pounds.

Other tools for the small workshop

In the Goodell-Pratt family of 1500 Good Tools are many other such tools made specifically for the small workshop. The catalog shows them all. Write for it. Just ask for Catalog No. 15.

GOODELL-PRATT CO., GREENFIELD, MASS., U. S. A.

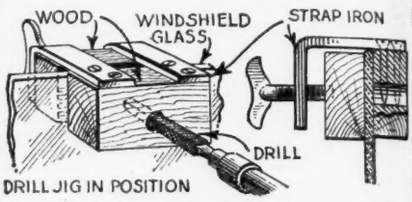
Toolsmiths

Makers of Mr. Punch

GOODELL-PRATT
1500 GOOD TOOLS

Simple Jig Prevents Breakage in Drilling Plate Glass

IN DRILLING plate glass for attaching windshield wipers, special inside spotlights, and similar purposes, the simply made drill jig illustrated has proved successful in preventing breakage. It consists of 2 blocks of wood, 2 small pieces of



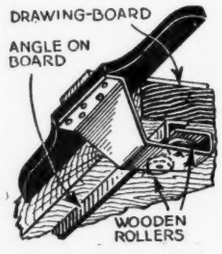
The drilling tool is guided by a wooden block clamped firmly against the glass

strap iron, 4 wood screws and 2 clamp screws.

The jig will serve with whatever type of tool is used for drilling the glass. Usually the tool is a file or a specially hardened steel drill kept wet with turpentine and camphor, or else a brass tube with an abrasive of turpentine and emery powder.

Roller Guide for T-Square

TO HOLD a T-square against the left-hand edge of the drawing-board at all times is the object of the device illustrated. This is especially intended for use on a large drawing-board not equipped with an ordinary parallel rule attachment.

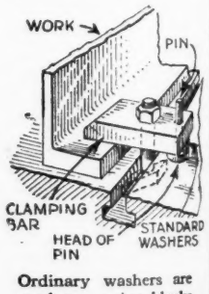


Keeps T-square head against drawing-board

A bent plate somewhat shorter than the length of the T-square head is fastened securely to the head. This plate carries a pair of wooden rollers. The rollers run against a track made of a brass angle, which is fastened to the under side of the board parallel with the edge.

Extension Blocking for Planer

A GREAT many of us know how aggravating it is to have a job blocked and clamped on the planer bed only to have the blocking slip on the first stroke. A good way to prevent this is to make a pin with a large head, provide the clamping bar with a hole through which the pin will pass, and use standard washers between the clamping bar and the pin head to act as spacers. Much time can be saved by using a set of these clamps in conjunction with a keg of 1- or 1½-in. washers.



Ordinary washers are used as spacing blocks

How to Use a Universal Dividing Head, is a Better Shop Method article that will appear shortly.

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Every Brandes Product is sold subject to the approval of the purchaser. If for any reason you are not fully satisfied, if you think it does not fully come up to our guarantee that it is better than any other at the price, return it to your dealer within ten days, and he will immediately refund the full purchase price.
He will not ask any questions. He will take your word, if the product does not meet with your approval. You don't have to prove anything to him.
This guarantee really amounts to a free trial.
President

A 16-year-old pledge

More than a million and a half Brandes Headsets and *Table-Talkers* are today doing valiant service! With each sale this time-tried guarantee assumes new strength and meaning. It is an old pledge that bespeaks the unlimited confidence of the manufacturer in his products—a confidence based on the continued acceptance of Brandes products by an alert public.

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Superior *Matched Tone* Headset $6
$7 *in Canada*

Table-Talker $10.
50¢ extra west of the Rockies
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The name to know in Radio

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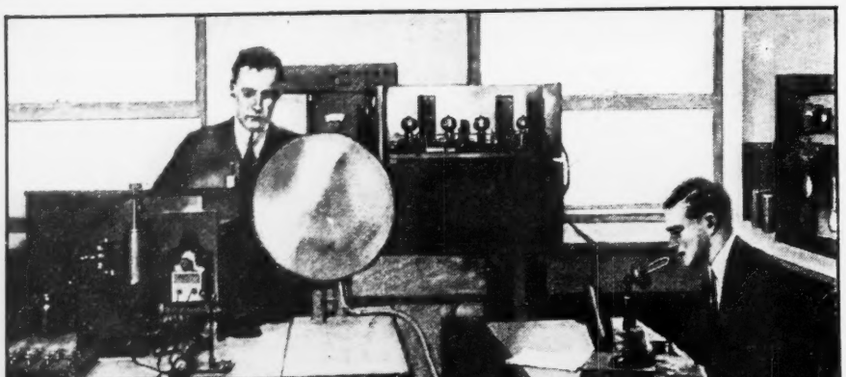

In the Bell System laboratories speech sounds are recorded on the oscillograph with a view to their subsequent analysis

The service of knowledge

The youthful Alexander Graham Bell, in 1875, was explaining one of his experiments to the American scientist, Joseph Henry. He expressed the belief that he did not have the necessary electrical knowledge to develop it.

"Get it," was the laconic advice.

During this search for knowledge came the discovery that was to be of such incalculable value to mankind.

The search for knowledge in whatever field it might lie has made possible America's supremacy in the art of the telephone.

Many times, in making a national telephone service a reality, this centralized search for knowledge has overcome engineering difficulties and removed scientific limitations that threatened to hamper the development of speech transmission. It is still making available for all the Bell companies inventions and improvements in every type of telephone mechanism.

This service of the parent company to its associates, as well as the advice and assistance given in operating, financial and legal matters, enables each company in the Bell System to render a telephone service infinitely cheaper and better than it could as an unrelated local unit.

This service of the parent company has saved hundreds of millions of dollars in first cost of Bell System telephone plant and tens of millions in annual operating expense—of which the public is enjoying the benefits.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY
AND ASSOCIATED COMPANIES

BELL SYSTEM

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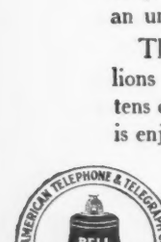

You Can Also Charge "B" Batteries At Home

The APCO "B" Battery Charger is a worthy ally to the successful APCO Charger for "A" batteries. Renews any 24 to 48 volt wet "B" battery in ten hours—without disconnecting set. It's noiseless, clean and as easy to hook up as an electric iron. Complete with wires ready to use, $10. Write for interesting circular and nearest dealer's name.

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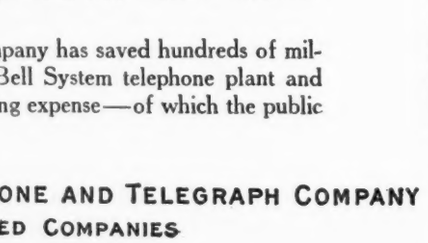

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Any MAN can sell them

And am able to average over $100 PER WEEK. Could do more only I do not put in much over half time. Personally I think it is the easiest sold article I ever handled as it has merit and is a necessity," says L.R. Graham, Illinois. A. H. Robey of W.Va. made over $500 in one month, Frank DePries has been with us six years—averages over $150 a week. Hundreds of our men making $60, $75, $100 a week. We need more men to fill unoccupied territory. Hundreds of prospects makes selling easy—garages, schools, stores, factories, shops, farms, homes, auto and truck owners, hospitals. Single sales bring big commissions. Largest concern of kind in world. Write quick about this position.

THE FYR-FYTER CO., 198 Fyr-Fyter Bldg., Dayton, O.

Telltale Aid in Setting Work for Taper Turning

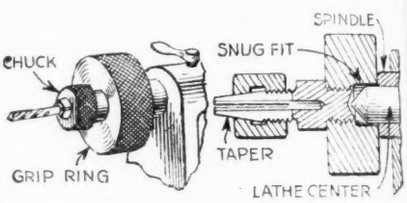
FOR setting over a lathe tailstock for cutting tapers, the simple telltale illustrated is a useful accessory. A piece of machine steel ⅝ by 1 in. and about 5 in. long is slotted as shown to take a finger made of ⅛-in. thick sheet steel pivoted on a ⅛-in. pin.

After the spots are turned on the work for the large and small diameters of the taper, the finger is placed in the tool-post and the tailstock is set over until the finger just touches each turned spot, the carriage being run back and forth.

Lathe telltale

Tailstock Holder for Light Drilling on Bench Lathe

ON THOSE frequent occasions when it is desired to drill a center or a small hole in work chucked in a bench lathe, the usual practice is to remove the part and do the drilling on a drill press. One way to avoid taking out the work is to use a hand drill holder that is inserted between the work and the tailstock center.

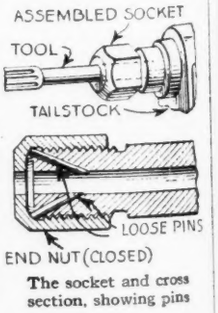


A ring that slips over the tailstock center holds centering countersink or small drill

This holder consists of a grip ring knurled on the edge and drilled in the rear face to fit snugly over the tailstock center, so that the rear face of the ring bears against the spindle. This insures the ring's being located centrally to the work. Screwed into the front face of the ring is a chuck for the centering countersink or small drill.

Diagonal Pins Hold Tools in Socket of Unusual Design

A TOOL socket that differs from the conventional type can be made inexpensively as illustrated. It consists of a threaded holder and nut with a closed end. Two diagonal holes are fitted, as indicated, with pins that are forced against the shank of the tool when the nut is tightened. For some purposes a single pin is sufficient.



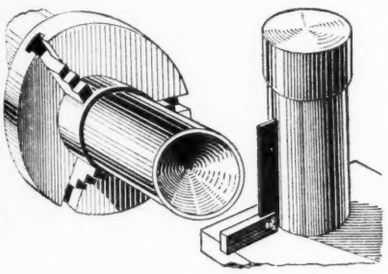
The socket and cross section, showing pins

For use in lathe or drill press, this form of tool can be made up at comparatively small cost, and it is suitable for taps, drills, counterbores, reamers, and various other cutting tools.—G. A. L.

Testing Alinement of Lathe and Accuracy of Square

TO DETERMINE accurately if the live spindle of a lathe is true with its ways, I chuck and turn a piece of metal of convenient diameter for a distance of 6 or 8 in. If the diameters at both ends of the cut are equal, then the spindle is true in a horizontal plane. In turning off this section, the last tool cut must be very light so as to reduce the wear of the tool to a minimum. For greater accuracy it would be well to grind the surface after it has been turned.

Checking the trueness of the spindle vertically in relation to the ways, an indicator is placed in the toolpost and traversed beneath the turned surface. Lack of movement of the indicator shows that the lathe spindle is alined correctly.



The special test piece used for checking a lathe spindle and testing a square

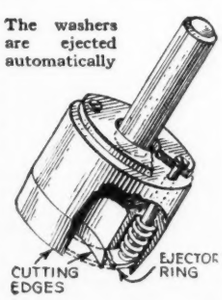
This same piece of stock can be used to test the accuracy of a square. First turn a conical center in the end of the metal; then bring the tail center into the turned center in order to true the tailstock and spindle. Now form a narrow flat edge on the end of the piece and place it on a surface plate, as shown.

A square, or any other right-angled tool, can be tested very quickly in this way.—JAMES F. HOBART.

Tool for Cutting Washers

WASHERS of any desired size may be cut rapidly from rubber, fiber, felt, or any material other than metal with a tool made as shown.

Between the cutting edges is a recess that contains a ring for ejecting the washers as they are cut. A ring of the same diameter is placed outside the tool on top and connected with the inner ring by means of two studs. These studs carry springs, so that each time the spindle is raised the washers that have been cut are automatically forced out of the tool.



Tool steel should be used. The edges may be resharpened without altering the size by grinding the bevel. The shank of the tool is held in a drill chuck or made with a taper shank, as preferred.

The material to be cut is placed on a board so that the cutting edges will not be dulled.—H. W.

We've Made You

A Unique Shaving Cream Will you please accept a test?

By V. K. CASSADY, *Chief Chemist*

Gentlemen:

Here is a Shaving Cream which millions are discussing. It does five things which men desire in a surpassing way.

The history is this:

Palmolive Soap, through its effects on the skin, had become the world's leading toilet soap. We desired to bring men those same effects in shaving.

But men, we knew, wanted other results. So we asked 1,000 men to tell us what they wanted most.

Then we worked 18 months to meet their requirements as no one else had done. We made up and tested 130 formulas to attain the utmost in a Shaving Cream.

Five astonishing results

1—Palmolive Shaving Cream multiplies itself in lather 250 times.
2—It softens the beard in one minute.
3—Its lather maintains its creamy fullness for ten minutes on face.
4—The extra-strong bubbles support the hairs for cutting.
5—The palm and olive oil content makes the cream lotion-like in its effect.

The result has been a sensation.

To add the final touch to shaving luxury, we have created Palmolive After Shaving Talc—especially for men. Doesn't show. Leaves the skin smooth and fresh, and gives that well-groomed look.

There are new delights here for every man who shaves. Please let us prove them to you. Clip coupon now.

THE PALMOLIVE COMPANY (Del. Corp.), 360 N. Michigan Ave., Chicago, Ill.

PALMOLIVE SHAVING CREAM

10 SHAVES FREE

and a can of Palmolive After Shaving Talc

Simply insert your name and address and mail to

Address for residents of Wisconsin, the Palmolive Company, (Wis. Corp)., Milwaukee, Wis., Dept. B-846. Address for residents other than Wisconsin, The Palmolive Company (Del. Corp.), 360 North Michigan Avenue, Chicago, Ill., Dept. B-846.

.....

.....

KLEIN PLIERS

It's worth while spending a little time, when you pick a plier for your kit. Ask your hardware dealer—he knows a lot about tools. And if it's quality pliers you buy, he will probably tell you to take a leaf out of the professional electrician's book and buy Klein's. There is sixty-seven years of experience built into every Klein plier — *sixty-seven years of manufacturing only quality tools!*

3220 BELMONT AVENUE
CHICAGO, ILL.

Mathias Established 1857 KLEIN & Sons Chicago Ill USA

Making the Most of Your Milling Machine

(*Continued from page 82*)

to be done except to mill this radius. It was eight o'clock in the morning and I had only six hours in which to machine the 60 pieces, but this looked easy enough, as I only needed to do 10 pieces an hour.

I went to the tool crib and asked for a concave radius mill with ¼-in. radius, but after looking all over the crib, the tool man said he had nothing but a 5/16-in. radius mill, so I was stuck. After a few minutes' thought, I looked up a block of cast iron of the form shown at *D*, turned up a stud, *E*, and inserted it as shown, then clamped down the block on the table of the milling machine. I centered the plug with the spindle as indicated. Next, I threaded a 5/16-in. rod 12 in. long for a handle and put in a 1-in. end mill (*F*).

Screwing the handle *C* into the rod-end *G* and placing the latter on the stud *E*, it was an easy matter to move the handle back and forth in the direction of the arrow and thus generate the radius required. As a matter of fact, I had the 60 pieces done a few minutes before noon, although some of them were a trifle rough. I touched them up with a file and removed the burrs, finally making a good job.

When I took the work to the foreman, he wondered how I had done it so quickly, and asked where I got the radius mill. I took him over to the machine and showed him the rig I had used. It developed later that the foreman knew there was no radius mill of the right size in the tool crib and had given me the job purposely, to see how I would make out. Incidentally, I received an increase in pay the next Saturday, presumably for the ingenuity displayed.

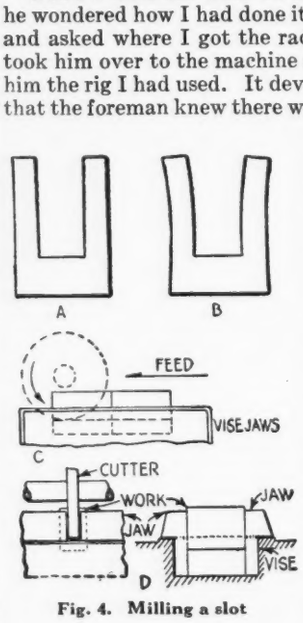


Fig. 4. Milling a slot

The ordinary milling-machine operator seldom stops to think that it often pays to take a little more trouble and set up two or more pieces at a time. Frequently they may be machined almost as quickly as one could be done. Take the example shown in Fig. 2. There were 50 shafts (*A*) in which keyways were to be cut as at *B*. Many operators would set up one piece at a time and clamp it in the usual way against a parallel in the T-slot, but by using blocks as shown at *C* and a single clamp between the pieces, they could be set up almost as rapidly and located as positively. Then, by using two cutters on the arbor, the production almost could be doubled.

A thin casting is always hard to hold and difficult to machine. "Chatter" is

(*Continued on page 95*)

Start with Their Early Training

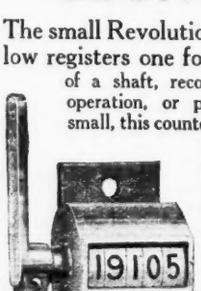
You can bring up machines to work fast and profitably, much as you build up good workmen.

By using a *counter* and getting a *record*, you can check up the output and *GAINS* in output as you perfect your machine mechanically.

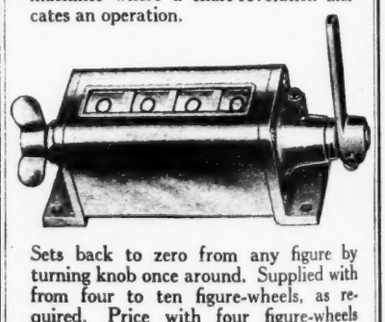
You'll develop better operating methods—and a better operator at the machine. Each new step, as it counts in *results*, will be measured for what it's worth—by your

Veeder COUNTER

The small Revolution Counter below registers one for a revolution of a shaft, recording a machine operation, or product. Though small, this counter is very durable; its mechanism will stand a very high rate of speed, making it especially suitable for light, fast-running machines and most adaptable to experimental work. If run backward the counter subtracts. Price $2.00. (*Cut 4-5 size.*) Small Rotary Ratchet Counter, to register reciprocating movements of small machines, also $2.00.



The Revolution Set-Back Counter below records the output of the larger machines where a shaft-revolution indicates an operation.



Sets back to zero from any figure by turning knob once around. Supplied with from four to ten figure-wheels, as required. Price with four figure-wheels as illustrated, $10.00—subject to discount. *Cut less than one-half size.* Set-Back Rotary Ratchet Counter, to record reciprocating movements as on punch presses, $11.50 (list).

Everything you need in a counting device goes to make up the 80-page Veeder booklet. You'll enjoy seeing a copy; gladly sent free.

The Veeder Mfg. Co.,
44 Sargeant St. Hartford, Conn.

Making the Most of Your Milling Machine

(*Continued from page 94*)

very apt to develop on this kind of work. If you clamp the piece too strongly, you are very likely to spring it out of shape and if too loosely, it will chatter or change position during machining.

Take the piece shown in Fig. 3 for example. This is a thin bronze casting, *A*, which is to be face milled on the flange *B*. We first set up this piece by means of setscrews in surrounding angle plates as indicated and started the cut. Before the mill had traveled 3 in., a persistent chatter developed, at which time the machine was stopped and setscrews tightened again. Before the first piece was completed, we had to stop the cutter four or five times and tighten the setscrews. We were using cone-point screws and changed these to the cup-point variety, which improved the situation slightly, but we were obliged to use a very light feed and high speed to prevent chatter. This made the operation slow and some distortion was apparent.

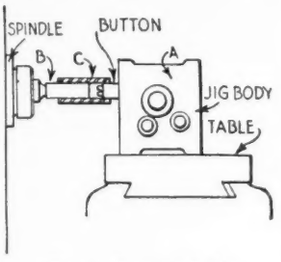


Fig. 5. Locating holes with sleeve and button

The trouble finally was overcome by using wooden blocks and jacks at *C* and *D* opposite the setscrews. By this means vibration was overcome and the screws could be tightened sufficiently to hold the work without causing distortion. A principle similar to this often can be used to advantage when holding thin or fragile work.

When you have occasion to cut a slot through a casting or a forging, as shown at *A* in Fig. 4, you are very likely to produce a result as shown in exaggerated form at *B*, in which the sides have sprung away from the cutter during the process of machining. If you put the piece in vise jaws, as shown at *C*, and mill through the slot lengthwise of the jaws, trouble will be caused by the cutter's binding and giving an inaccurate slot when finished. If you cut crosswise of the jaws, you will have a result similar to that shown at *B*.

Several solutions are possible in a problem of this kind. If you have only one piece of machine, you can take a cut through the center first and then a light finishing cut on both sides, using a rather high speed and fine feed. The operation can be done with a single cut by using special jaws as shown at *D*, high enough to support the sides well and obtain a good grip to prevent spring. If there are a number of pieces to be machined, this is, of course, the best way to do the job; but if only a few are to be made, it would hardly pay to make up jaws specially.

When using a milling machine for the accurate boring of holes, as often required in jig work, care must be taken in setting

(*Continued on page 96*)

Work on your radio with

"YANKEE" RADIO TOOLS

They make radio construction easy, save time, do better work.

It's fun! You just move handle of "Yankee" Tool Holder back and forth on ratchet movement.

The tool countersinks, reams, runs up nuts, drives screws. Attachments for these operations fit holder.

A touch on Ratchet Shifter gives you right- or left-hand ratchet; or rigid adjustment

"Yankee" Radio Drill No. 1431, capacity 9-32 inch, is just right for radio jobs. In addition to use on your radio, you will find these tools handy for general use around the house.

"YANKEE" Radio Set No. 105

"YANKEE" Radio Tool Set No. 105
Price $3.25

All these attachments fit "Yankee" Ratchet Holder:
Blades—one for long reach into box, between wires, etc.
—one for small screws on dials.
—one for heavy screws—putting up aerials, etc.
Countersink—for heads of screws.
Sockets—(two) cover all small nuts.
Reamer—for enlarging holes in panel.
Wrench—one end, square or hex. Other, hex for jacks.
Wire Bender—for bending wire and making loops.

"YANKEE" Drill No. 1431
Price $3.00

4 to 1 gear for speed. Special Radio Chuck to take largest drill usually supplied with radio drill sets.

Your dealer can supply you
"Yankee" Tool Book Free on request

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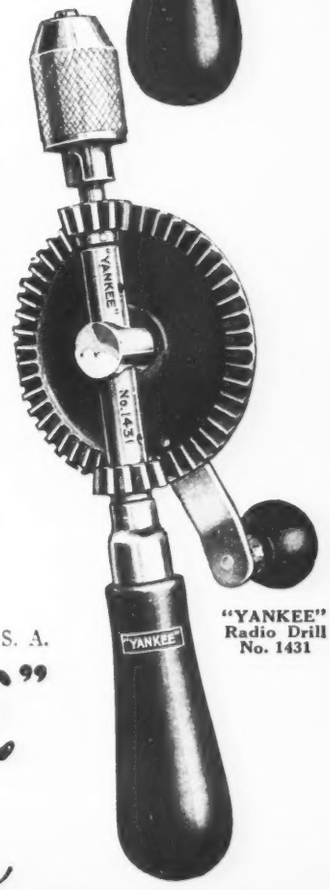

"YANKEE" Radio Drill No. 1431

"YANKEE" TOOLS
Make Better Mechanics

Williams
Shaving Cream

Even the cap was designed for speed

If you like to make race track speed in the morning, Williams Hinge-Cap will appeal to you. Slippery fingers can't drop it. Carelessness can't lose it. For the cap's hinged on. It simply can't come off.

As for the shaving cream, it was designed especially for men with wiry beards and tender skins.

Williams works up into a rich, creamy lather almost instantly. And as the razor glides across your face you experience a new sensation. Each stroke is lubricated. Razor friction is removed. And when the shave is over, your face feels clean, cool and delightfully refreshed.

Try Williams tomorrow morning. Large size, 35c. Double size, 50c, containing almost twice as much cream.

THE J. B. WILLIAMS COMPANY
Glastonbury, Conn.

The J. B. Williams Co. (Canada) Ltd., St. Patrick St. Montreal

WE'VE scored again! *Aqua Velva* is the new product—a *scientific* preparation for use after shaving. For free trial bottle, write Dept. 109.

Making the Most of Your Milling Machine

(*Continued from page 95*)

from one hole to another. It is seldom advisable to depend upon the micrometer dials on the machine, although these may give a close approximation to the sizes. The majority of operators are more or less familiar with the button method of locating holes that are to be carefully bored in a given relation to each other.

In applying this method to the milling machine, if we assume that the work has been carefully laid out and the button applied, the piece can be set up on the machine as indicated at *A* in Fig. 5. After this has been done and the piece clamped against an angle plate or on the table, according to requirements, we must provide a hardened and ground plug *B*, lapped accurately to the exact size of the button used. This plug is inserted in the spindle as shown, and a sliding sleeve, *C*, is placed over it. This sleeve must be a very nice fit, without any shake whatever.

In use, the table must be adjusted until the sleeve can be slipped freely from the plug over the button, at which time it is evident that button and plug are in alinement. Back-lash in feed screws must be taken out when alining button with sleeve, and if the former is a trifle higher than the plug, lower the knee *below* the required point and then bring it up again, to take up all lost motion in the screw. In making longitudinal adjustments, the same idea must be followed.

AFTER the spindle is set, the button and plug are removed and a drill is inserted in the spindle, to be followed by the usual boring bar or reamer. It is always best to generate the hole accurately by means of a boring tool, as the reamer may be slightly off center and thus cause slight errors in the position of the hole. A careful operator can obtain very good results by this method, although some prefer to mount an indicator in the spindle and obtain the setting by adjusting the table until the indicator reads the same at four points 90 degrees apart around the button. It is rather difficult to see the indicator pointer in some positions, but this difficulty can be overcome by using a small mirror and an electric light. As a general thing, this method of location produces more accurate results than the plug and sleeve arrangement.

For short jobs, don't worry too much about your feed and speed, because the cutting time is less important than the setting up. Use a conservative feed and speed and spend your time to the best advantage by studying out a simple and accurate method of setting the work in position and holding it there when you have placed it properly. Ordinarily use slow speeds and comparatively coarse feeds for roughing cuts, with higher speeds and finer feeds for finishing. Chatter often can be avoided by changing the relation of feed and speed.

Cast iron usually is cut dry. Bronze and aluminum can be cut either dry or with a lubricant. Tool steel or alloy steel and steel castings are best cut with a lubricant. Plain lard oil is very good, but

(*Continued on page 97*)

RADIO

Elements of Radio Communication
E. W. Stone

For the man who wishes to understand the general theory of radio communication. A complete, up-to-date discussion presented in simple terms, of every phase of radio-telegraphy and radio telephony.

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Double page Radio maps of the United States, Canada, the World. Broadcasting stations of the world with call signals, wave-lengths and ownership. General Radio information. Size 12" x 15".

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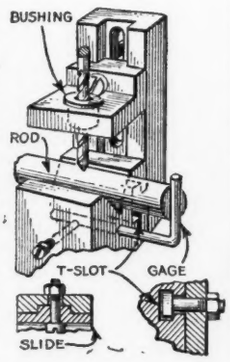
Cram's Radio Map

A comprehensive Radio Map of the United States and Canada, showing government, commercial and private stations: completely indexed. Size 28" x 34".

Price, Thirty-five Cents

Popular Science Monthly
250 Fourth Avenue,
New York, N. Y.

Adjustable Jig for Drilling Holes in Round Bars

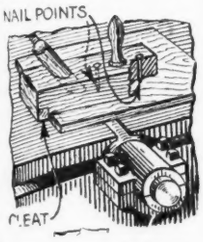


A CHEAP and yet accurate jig for drilling holes in round stock can be made as illustrated. A square block, provided with a V-groove, is fastened to the upright by means of a T-slot. The upright is grooved to allow the bushing bracket to be adjusted up or down.

A ½- or ⅜-in. hole is drilled in the end of the block to receive a bent rod, which acts as a gage. The gage is held in any desired position by a setscrew.

Safety Handle for Jointer Holds Thin Stock Firmly

WHEN planing thin strips of wood on the jointer, the danger of accident may be reduced by providing a handle or holder made as shown. It is placed over the strip to be planed, the end of which is caught against the cleat. The latter may project ⅛ or ¼ in. below the lower surface of the holder, as desired. Two sharp pointed nails which project slightly through the holder, prevent the strip from moving sideways under pressure.



Holds thin stock firmly

Making the Most of Your Milling Machine

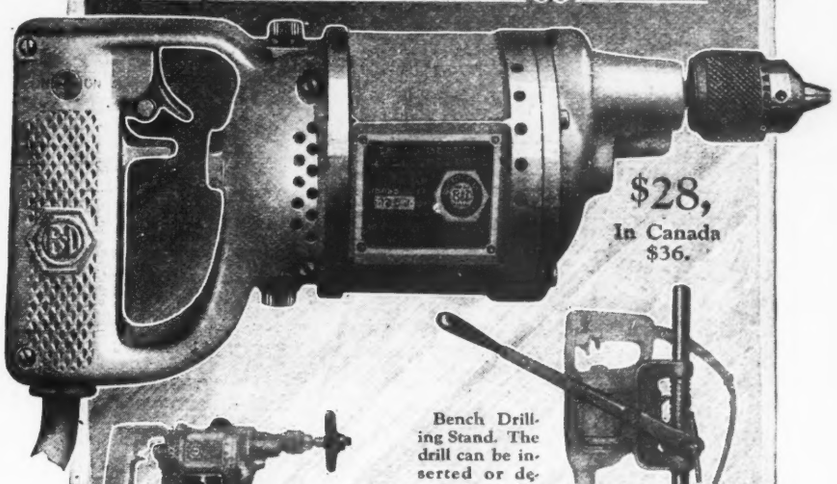
(*Continued from page 96*)

for very hard materials white lead and oil give a smoother cutting action and this composition also has the property of clinging close to the cutter and adhering to it more than does plain oil.

In high production milling, a compound usually termed "soda-water" often is used, but for short-job work machines are seldom provided with pump and tank needed for this sort of lubrication. It should be remembered that the lubricant serves two purposes, reducing friction and cooling the cutter. For short jobs we need it mostly for reducing the friction and making the cutting action easier.

Many operators dislike using lubricant on a milling machine because the oil and chips cling to both cutter and work and make it more difficult to see the action of the cutter. When the lubricant is used only in small quantities, it has no force and being only a small stream it does not carry away the chips. Likewise the chips and oil muss up the machine. This is a lazy man's point of view and should not be tolerated by a good operator, for it is certainly much cheaper to spend a few minutes in cleaning up the machine than it is to regrind a cutter.

BLACK & DECKER
QUARTER-INCH PORTABLE ELECTRIC DRILL
"With the Pistol Grip and Trigger Switch"



$28, In Canada $36.

Grinding Outfit.—Consists of stand which can be fastened to bench top, arbor with clamp washers and nut, and grinding wheel. $3—In Canada $4

Bench Drilling Stand. The drill can be inserted or detached quickly by means of handle clamp. $12, In Canada $16

Nine Tube Radio Receiver In Three Evenings

One radio fan says his Black & Decker Electric Drill enabled him to build a "Set" consisting of Three Stages of Radio Frequency, Two Stages of Audio, and a Three Tube Push-Pull Power Amplifier, in three evenings at home.

This included making the panel and the process he devised will interest other fans; this is how he did it:

Mounted all instruments on the base in the best positions to insure short grid and plate leads. (Longest grid or plate lead on the set is 2 inches.)

Laid out panel on a sheet of wrapping paper cut to the exact size of the panel. Panel instruments were located to avoid interference with base instruments—to insure shortest possible connections—for convenience in operating and symmetrical appearance.

Under side of this paper pattern was then coated with ordinary library paste and pasted to front of panel. With a brad awl centers were punched thru paper and a ⅛th inch lead hole drilled thru every center punch mark. These were followed up with various size drill bits to accommodate the various mountings. (Sizes of holes having been indicated on the paper pattern.)

By using the electric drill and stand all these holes can be drilled before the paste has dried. This is important because the paste will not hold on the panel after it is dry. When paste is dry, paper pattern is merely lifted off and the panel wiped clean with a wet cloth.

This Panel, Angle Brackets for Binding Post Panel and Binding Post Panel itself required the drilling of 60 holes of various sizes. The Drill and Stand enabled this man to drill so accurately that every instrument was mounted easily without additional fitting, resulting in a 100% panel job. Photograph of completed panel will be mailed on request.

Every radio builder should have one of these drills and stands.

Orders and inquiries may be mailed to

THE BLACK & DECKER MFG. CO.

700 Pennsylvania Avenue, Towson, Maryland

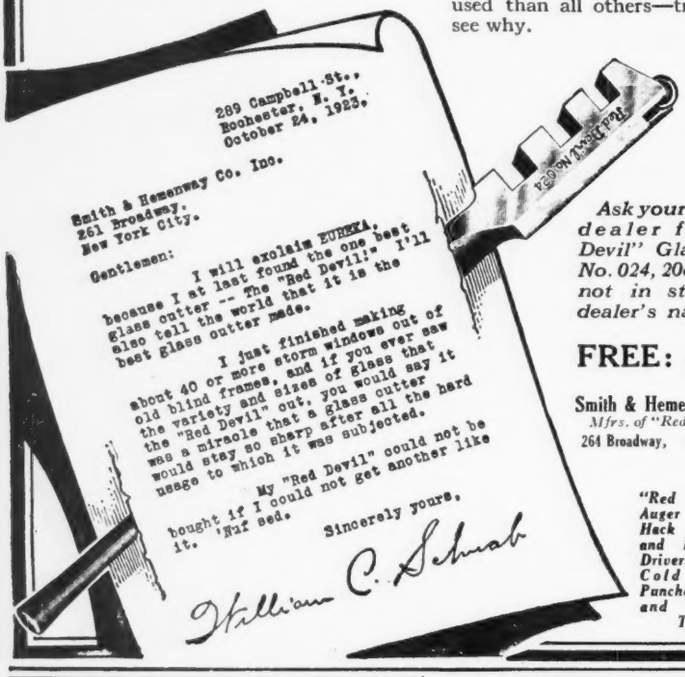
"Red Devil" Glass Cutters

The Glaziers' Standard

IT'S economical to do the little home glazing jobs yourself with a "Red Devil."

The hand honed steel cutting wheel cuts clean and sharp, with the slightest pressure—stands the test of hard use. The handle is shaped to fit the fingers without tiring.

More "Red Devil" Glass Cutters used than all others—try one and see why.


289 Campbell St.,
Rochester, N. Y.
October 24, 1925.
Smith & Hemenway Co. Inc.
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I will exclaim EUREKA,
because I at last found the one best
glass cutter -- The "Red Devil!" I'll
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best glass cutter made.
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about 40 or more storm windows out of
old blind frames, and if you ever saw
the variety and sizes of glass that
the "Red Devil" cut, you would say it
was a miracle that a glass cutter
would stay so sharp after all the hard
usage to which it was subjected.
My "Red Devil" could not be
bought if I could not get another like
it. 'Nuf sed.
Sincerely yours,
William C. Schwab

Ask your hardware dealer for "Red Devil" Glass Cutter No. 024, 20c. each. If not in stock, send dealer's name.

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Smith & Hemenway Co., Inc.
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"Red Devil" Pliers, Auger Bits, Snips, Hack Saw Frames and Blades, Screw Drivers, Chain Drills, Cold Chisels and Punches, Linemen's and Electricians' Tools, etc.

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PARKS Cabinet Shop Special is as complete a small shop equipment as you can buy! Everything in one compact unit with motor!

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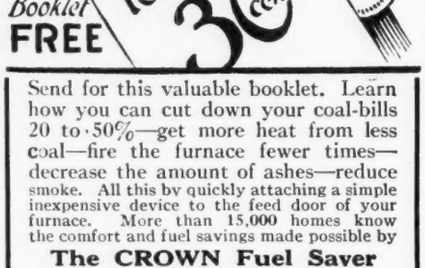

Send for this valuable booklet. Learn how you can cut down your coal-bills 20 to 50%—get more heat from less coal—fire the furnace fewer times—decrease the amount of ashes—reduce smoke. All this by quickly attaching a simple inexpensive device to the feed door of your furnace. More than 15,000 homes know the comfort and fuel savings made possible by

The CROWN Fuel Saver

GUARANTEED to make at least a 20% coal saving or your money back

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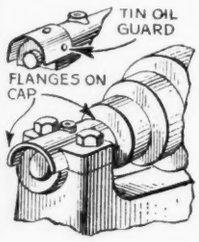
DISTRIBUTORS WANTED—High-grade men who seek a steady income. Write or wire.

Large Cap Prevents Speed Lathe from Splashing Oil

ANY one who has been splashed with oil thrown by the spindle of a wood-turning lathe will appreciate the method of protection indicated in the accompanying illustration. The bearing cap is made about 1 in. longer than the lower half of the bearing. This allows ½ in. to project on each side, the cap being cut back to allow the hubs to revolve under it.



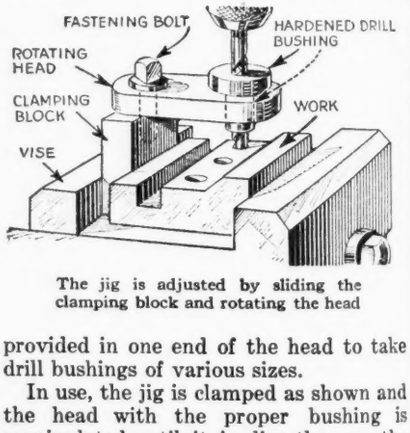
Two types of oil guard

If the expense of making new caps is to be avoided, a piece of tin fastened on each side of the cap will serve the purpose.—F. N. C.

Adjustable Drill Jig

THE simple drill jig illustrated is a useful fixture because it can be adjusted to suit the location of various holes that have to be drilled in straight flat work and shafts, as well as pin holes in studs and similar work.

A rotating head is pivoted to a block that can be clamped along with the work in the drill-press vise. A bushing hole is



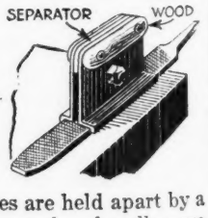
The jig is adjusted by sliding the clamping block and rotating the head

provided in one end of the head to take drill bushings of various sizes.

In use, the jig is clamped as shown and the head with the proper bushing is manipulated until it is directly over the proper spot, the adjustment being obtained by sliding the jig block along the vise jaw. The fastening bolt and the vise screw then are tightened to clamp the jig in place.—G. A. L.

Holder for Surface Filing

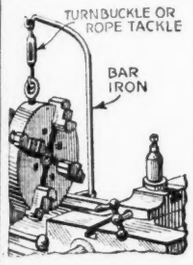
A TOOL for the mechanic who has a great deal of surface filing to do can be made by bending two pieces of ½-in. plate to form a file holder as shown. The plates are held apart by a separator and two wooden handles are riveted to them. The central clamping bolt is screwed up tight to hold the file between the jaws.



TO ANNEAL high speed steel, heat slowly to a dark red; cover with lime or ashes, and allow to remain until cold. It can then be worked as soft steel.

Lift Attached to Lathe for Handling Heavy Chucks

REMOVING a heavy chuck from a large lathe is a task that is lightened greatly by the use of the special lift illustrated. When the design of the lathe permits, this may be fastened directly to the back of the bed, or it may be carried down to the floor and braced from the lathe bed.



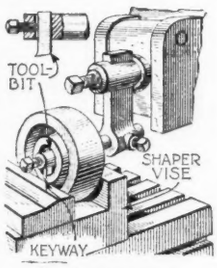
Allows one man to handle large chuck

The upright is a bent bar iron with a hooked end. This supports either a short turnbuckle or, if the stand is high enough, a small rope tackle. A hole is drilled and tapped in the chuck to receive an eye-bolt.

When removed from the rest, the chuck may be swung to one side and allowed to hang ready for use when wanted. This allows one man to handle a heavy chuck.

Shaper Tool for Keyways

WHEN no regular key-cutting machine is available, keyways may be cut quickly in the shaper with the tool illustrated. The holder, forged to shape as shown, has a ¼-in. reamed hole that takes the tool bar. In the end of the bar is a toolbit, held with a setscrew. If the holder is pack hardened, it will give and wear longer.

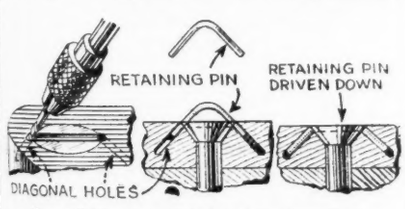


Cutting keyway in small pulley hub

Bars can be made of different lengths and sizes. For work on short bushings, gears and small pulleys, this tool-holder is a real time-saver.

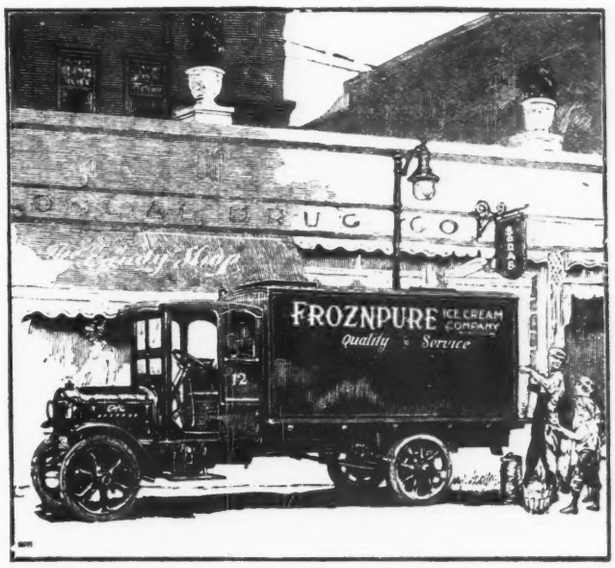
Lock Pins Prevent Turning of Countersunk Screws

THE countersunk screw is one fastener for which ordinarily no method of locking is provided. In some cases, it is true, the head is chiseled, riveted, or prick punched, but these methods cannot be depended upon always to hold against vibration and other strains.



A small bent steel rod is driven into diagonal holes to lock the screw-head slot

In one shop countersunk screws are locked by the simple but effective method illustrated. Two small holes are drilled diagonally at the ends of the screw slot and into these is driven a steel rod of the same diameter, which straightens out into the screw slot and holds the head.



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Big mileage free from anything but casual service attention. Overstrength in every part.

Long miles fully loaded up steep grades through bad going—bad roads or good look the same to the now famous GMC Two Range Transmission. It enables a GMC and its load to go anywhere the wheels can get traction.

Big mileage on gasoline and oil. The Two-Range Transmission furnishes both speed and pulling power *with an engine of economical size.*

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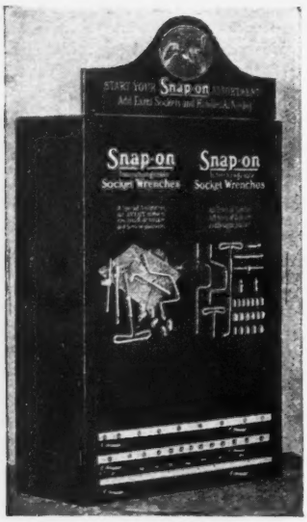

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Easily Built Aquarium and Stand

By William J. Edmonds, Jr.

A SMALL aquarium lends a touch of color and interest to a sun porch, living-room or dining-room that well repays the cost and labor of building one. Not only has it a decorative quality that is difficult to duplicate by other means, but it provides a fascinating study for the children. Its revelations become more interesting the longer it is left unagitated, and for that reason the aquarium illustrated is of such a size that it can remain undisturbed for some time.

To construct it, first obtain about 18 ft. of ¾ by ¾ by ⅛ in. angle iron for the frame (Fig. 1). This may be bought at any hardware shop or dealer handling iron and steel; it should cost about 50 cents.

The ends of the horizontal rails, *A*, should be beveled at 45 degrees with a hacksaw and finished with a file. The pieces then are drilled for 3/16-in. rivets. These holes are not countersunk.

The vertical or corner pieces, *B*, next are cut and drilled, as indicated, and the holes are countersunk on the inside for the rivets. The holes in these pieces should be marked according to the holes already drilled in the horizontal pieces, *A*. It also may be well to mark each piece so that the pieces will be assembled in the same order as they have been laid out.

When the frame is together, it is taken to a glazier and fitted at the sides, ends, and bottom with ¼-in. plate or double thick window-glass. The bottom glass should be a good fit, but the sides and ends should be slightly shorter to allow the cement to be pressed into the joints to form a dovetail, as shown in Fig. 1. The space marked *C*, which is found between the glass and the horizontal pieces, should be filled with cement, for if these spaces were allowed to remain open, the pressure of the water might spring the glass and cause a leak at the corner joints.

The cement is made as follows: Litharge, fine dry white sand, and plaster of Paris, each 3 parts, and fine pulverized rosin, 1 part, are mixed together thoroughly with boiled linseed oil, to which a little drier has been added. Beat the mixture well and let it stand 3 or 4 hours before using. When the glass has been cemented in place, the aquarium is left to dry for 3 or 4 days before water is placed in it, and 3 or 4 changes of water are then made, allowing 1 or 2 hours between changes before any stock is put in.

The frame is finished in any color enamel desired.

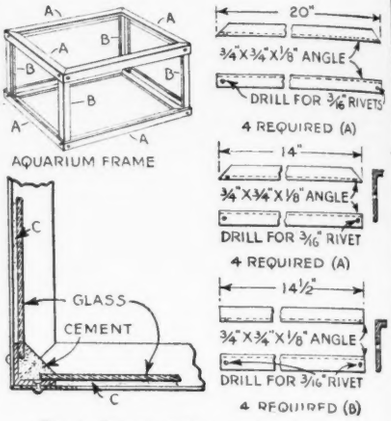
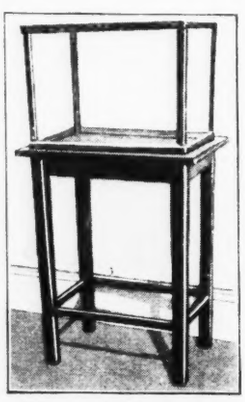


Fig. 1. Details of the aquarium framework and method of cementing the glass in place



The completed aquarium on its wooden stand

This aquarium, of course, can be placed on any convenient table or stand, but it looks particularly well when set upon a stand made specially for it as illustrated. This stand is very simple in construction. The top, *A*, Fig. 2, is made of two or more pieces of stock dressed ⅞ or ¾ in. thick and glued together. It is advisable for the amateur woodworker to use at least 4 dowels in each joint.

The upper rails, *B*, and the lower rails or braces, *C*, are of the dimensions given. These pieces have tenons cut on the ends to fit mortises in the legs. The legs, *D*, are dressed to 1½ in. square and have mortises cut as shown. After the pieces are cut and have been fitted together, the joints are made with a good grade of glue and the top is fastened in place by means of wood screws passing through the upper rails into the top, holes first being bored to allow the heads to sink into the rails. Table-top fasteners, which can be obtained at a hardware store, or wooden blocks, may be used for holding the top if the builder prefers.

After the stand is assembled, it is cleaned with sandpaper or, if made of hard wood, scraped and sandpapered, and then given a coat of stain and filled. It is then shellacked and waxed or varnished.

Stock for the aquarium may be purchased from any dealer in aquarium supplies, or may be selected from slow-running streams or ponds.

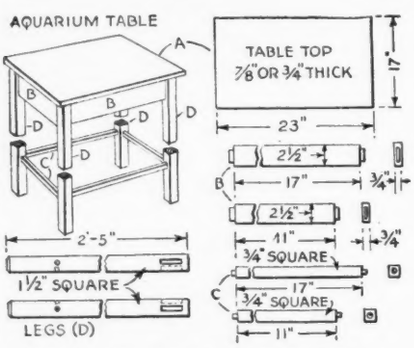


Fig. 2. The stand with dimensioned details of the top, rails, legs, and stretchers

An article by Mr. Edmonds on building a mission rocker is scheduled for early publication.

Blueprints for Beginners to Be New Workshop Feature

"I CAN'T build any furniture," recently remarked a friend to the Home Workshop Editor of POPULAR SCIENCE MONTHLY. "I haven't the time nor the tools nor the knowledge. Manual training wasn't taught in the school I attended, and I never learned to do anything but ordinary little woodworking jobs around the house. You show me something that looks really well and yet can be made without mortises and tenons and dovetails and dowels and a whole lot of time - consuming cabinet work!"

It was a difficult challenge, yet one long foreseen. Indeed, the Editor had his answer ready. It was in the form of a drawing for the first of a new series of blueprints for beginners—a design for a radio cabinet calling only for simple butt joints and workmanship of the most elementary kind. Yet this cabinet has a finely figured, veneered case as well as the overlay type of ornamentation and two-tone finish now so popular. The design and working details will appear next month.

Complete List of Blueprints

ANY one of the blueprints listed below can be obtained from POPULAR SCIENCE MONTHLY for 25 cents. The Editor will be glad to provide, upon request, information relative to tools, material, or equipment.

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Send me the blueprint, or blueprints, I have underlined below, for which I inclose.....cents:

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28.	Pullman Play Table	25c
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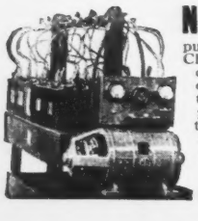

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How to Keep Your Automobile Polished

(*Continued from page 79*)

is to use a sponge, which alternately is dipped and squeezed over the surface. It is permissible to use the force of the hose under the mudguards.

Clean chamois should be used immediately to dry the varnish.

Good polish of various grades is obtainable ready prepared. A polish containing grated beeswax or cedar oil is desirable, and paste wax polish, which comes in small tins, is excellent. The writer has a preference for a simple paraffin polish, which is made by dissolving shavings of household paraffin for several days in the smallest possible quantity of clear turpentine.

By the use of these wax or paraffin polishes, the surface of the varnish is covered by a glasslike coating. This will respond with a bright luster when rubbed with the cheesecloth, and it will shed rain.

FOR winter use, when the owner is not concerned as much about the gloss as he is about preserving the finish, a protective polish made of two parts of boiled linseed oil and one part of turpentine will be found even more protective than wax polish. If desired, varnish can be added to the turpentine, using one part in five. A polish so made is applied with a cheese-cloth pad. Monthly applications of these oil polishes will result in excellent preservation of the varnish throughout the winter. A clean turpentined cloth will remove the linseed-oil polish before returning to the more brilliant wax polish in the spring.

For top preservation, the use of raw linseed oil and turpentine, two parts to one, is excellent. Never use gasoline or kerosene on imitation leather top or upholstering, as it dissolves the coating. Use Castile soap and clear water to wash the top as well as the body.

The upholstery also can be washed, if of leather or imitation leather, and can be polished with a cloth slightly dampened with the paraffin polish.

Washing the car in sunlight or washing the engine hood while it is hot should be avoided, because the varnish is almost certain to become spotted.

To summarize the care of the finish as practised so successfully by Jackson:

1. Avoid direct sunshine if possible, by parking in the shade, and protect your car from rain and snow by running it into the garage or by application of oil and wax polishes to shed the water.

2. Before using a cloth on varnish, remove grit and mud with a duster or by flushing off with water.

3. Use a good grade of wax polish over the varnish, and apply it only after the removal of all grit and dirt.

4. Use only cleaning materials that are free of grit and keep all cloths and materials in a separate closet where they will remain clean.

WHEN painting a floor in a room that is much used, I usually paint a few pieces of burlap, old oilcloth or linoleum with the same color and use it to cover spots that get particularly hard wear.—O.M.A.

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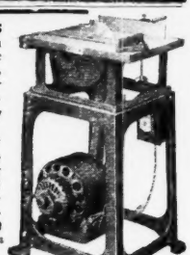

Elements of Industrial Chemistry

By Allen Rogers

General Processes; Water, Its Uses and Purification; Fuels; Sulphuric Acid; Nitric Acid; Elements and Inorganic Compounds; Ceramic Materials and Products; Pigments; Fertilizers; Illuminating Gas; Coal Tar and Its Distillation Products; the Petroleum Industry; the Destructive Distillation of Wood; Oils, Fats and Waxes; Lubricating Oils; Soap, Soap Powder and Glycerine; Essential Oils; Resins, Oleo-Resins, Gum-Resins and Gums; Varnish; Sugar, Starch, Glucose, Destrin and Gluten; Textiles; Dyestuffs and Their Applications; the Paper Industry; Explosives; Leather.

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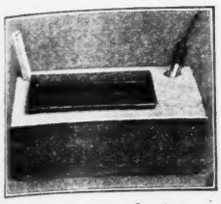
POPULAR SCIENCE MONTHLY
250 Fourth Avenue, New York, N. Y.

Keeping Photographic Developer at Correct Working Temperature

AMATEUR photographers who have their darkroom in the cellar often find the problem of keeping their developer in the neighborhood of 70 degrees a difficult one. Cellar temperatures range from 50 to 55 degrees in winter weather to 60 to 65 degrees in the summer.



Electric water heater keeps tray warm

In my own case the device illustrated solved this problem satisfactorily. It consists of a tin tank holding about 2 gals. of water set in an asbestos - lined box. The top is two thicknesses of tin with asbestos interlining. The opening for the tray is just large enough to allow it to settle down in contact with the water.

Openings also are provided for a thermometer and an electric immersion heater. —C. E. WEIBEZAHL, Syracuse, N. Y.

How to Install Automatic Light in a Clothes Closet

DARK clothes closets usually can be equipped with electric light at small cost. The best installation includes an automatic door switch, which turns on the light when the door is opened and turns it off when the door is closed.

If the closet is on the second floor of a two-story house, the wires usually may be run in the attic. If on the first floor, the easiest way often is to bring the wires from underneath the floor.

The material required is a sufficient amount of No. 14 rubber-covered wire to run from the lighting wires already installed, a few porcelain knobs or cleats to hold the wire from the wooden beams, about 10 ft. of 7/32-in. circular loom to incase the wires where they come through plaster and where they run on the surface of the wall down to the switch, a keyless receptacle for concealed work, with either an automatic door switch or a door-mounted hand switch. A small piece of solder and tape also are necessary.

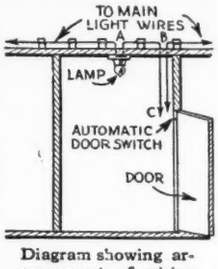
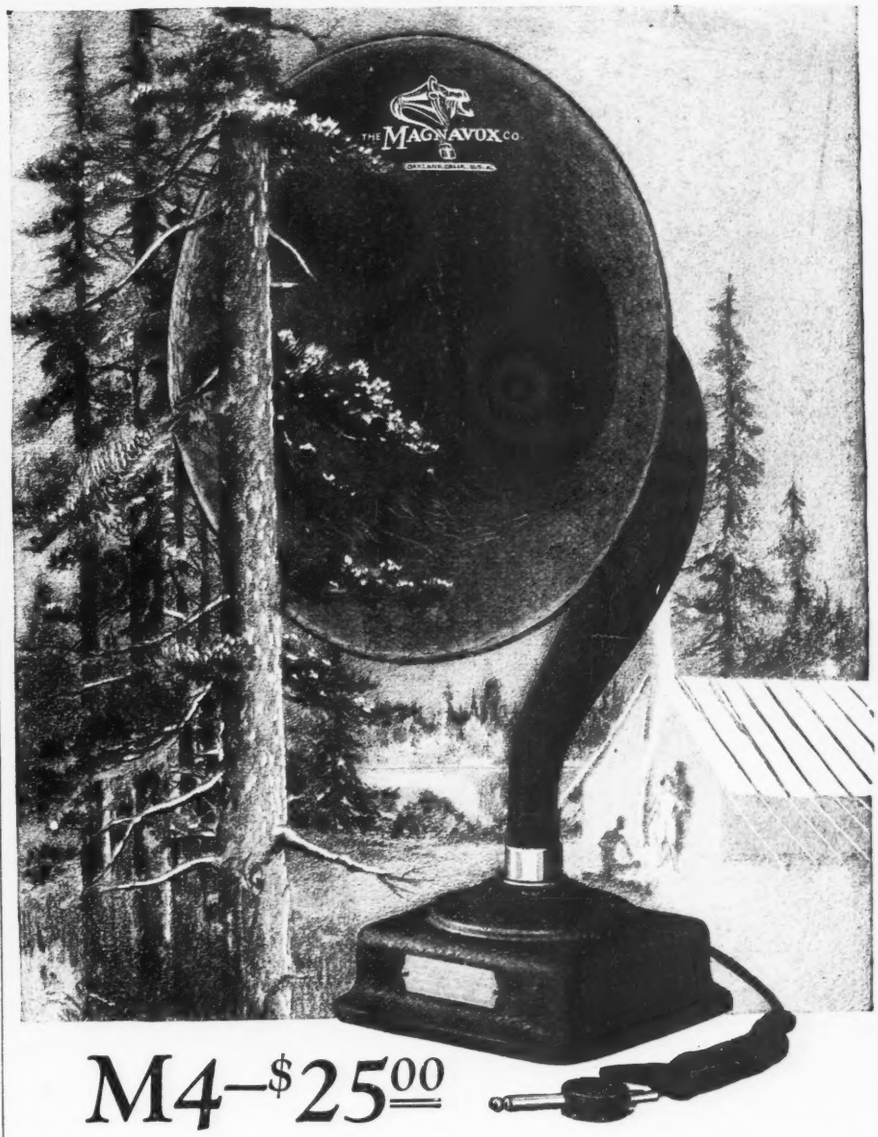


Diagram showing arrangement of wiring

To conform to the requirements of the Board of Fire Underwriters, it is necessary that wherever the wires are tapped on to the main house line, the joints must be soldered and wrapped with rubber and friction tape. The wires must be supported from the framework or beams on porcelain knobs or cleats, and circular loom must be used, as indicated above.

If the wires are run under the house, BX cable or conduit must be used unless the distance from the floor to the ground is 5 ft. or more, in which case open knob and tube work and rubber-covered wire will do.—C. P. ANDREW, Charlotte, N. C.



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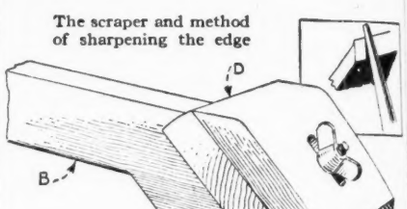
How to Make a General Utility Scraper for Woodwork

A GOOD scraper is an indispensable tool in the home workshop. It is useful for smoothing hardwood floors preparatory to sanding and finishing, even though a weighted, wheel-mounted scraper or motor-driven sanding machine has been used first. It is of value in surfacing and smoothing all kinds of new woodwork, for cleaning old floors that are to be refinished, for removing rust and scale from metal, and for taking off old paint, varnish, or putty from wooden surfaces.

When a commercial scraper holder is not available, a substitute may be made as shown. Use a piece of seasoned beech, maple, or other hard wood about 1¼ in. thick and 15 in. long for the handle, *B*. Cut the end at an angle of 45 degrees to take the tool seat, *C*, which should be of hard wood 3 in. long, measured with the grain, 4½ in. wide, and at least ¾ in. thick.

The scraper and method of sharpening the edge



Bevel the lower edge and round the upper edge. With a rabbet plane or a sharp chisel, cut a recess across the face of this piece, slightly less in depth than the thickness of the scraper blade, *A*. Attach it to the handle with flathead screws. The clamp, *D*, is ¾ by 3 by 4½ in. hard wood cut with the grain running up and down, at right angles to that of *C*. A bolt with thumb-nut hold this against the tool seat, clamping the blade.

The blade may be a cabinet scraper, a piece of steel cut from an old saw blade, or similar hard, well-tempered steel. Two opposite edges are filed or ground to an angle of about 45 degrees and, for fine work, rubbed on an oilstone to a chisel-like sharpness. Then clamp the blade in a vise and draw across it from end to end a burnisher, nail-set, or other hard tempered tool. Use considerable pressure and gradually turn the edge over. A little experimenting will show the amount of burr that will take off a fine, clean shaving from a wooden surface. If the burr is turned over too far by accident, it can be raised by running along it the point of a burnisher or penknife.

To use the scraper, apply pressure against *D* with one hand and with the other hand draw the handle toward you, with long, regular strokes. Keep the handle parallel with the surface of the work.

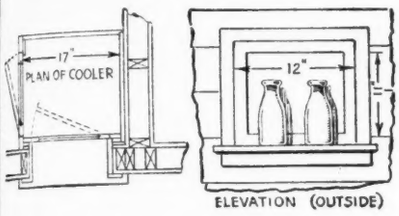
When one edge of the cutter becomes dull, the blade may be reversed. Burnish the edge frequently and resharpen it at intervals, as necessary.—HOWARD E. GOOD, Waterville, Ohio.

Outside Service Door Improves a "California Cooler"

By A. May Holaday

IT IS difficult to estimate the number of steps saved every week by the use of a small service door set into the "cooler," as the ventilated cupboard so common in California is called, or, indeed, any kitchen cupboard that is built against an outside wall.

At a convenient height for the milkman, an opening is cut through the wall and cased all around like a window. A small



Milk bottles placed on doorsill are taken in by reaching through cooler from inside

12 by 12 in. door is hinged to open inward between two shelves of the cupboard, and is fitted with a cupboard catch.

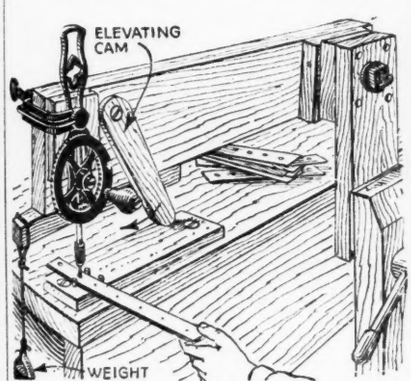
By reaching through the inside door from the kitchen, one can place empty bottles through the outside door-opening onto the flat sill, where the milkman replaces them with full bottles.

Thus, instead of taking many steps across kitchen and back porch, the housewife merely opens her cupboard door, and draws the full bottles of milk inside to the cool cupboard.

Small Drill Press Quickly Made for Emergency Use

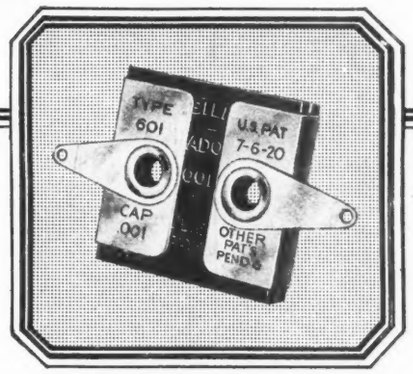
IN AN emergency, when several hundred holes have to be drilled in sheet-brass parts, a drill press was quickly made from material on hand in my home workshop.

A 1¼-in. plank, 8 in. wide and 2 ft. long, was pivoted by means of a bolt and



Hand drill clamped to pivoted plank provides means for doing light drilling speedily

wooden spacers to a shorter plank and the latter was gripped in the bench vise. A hand drill then was fastened to the free end of the longer plank with a C-clamp. An arm of thin wood pivoted as indicated to the long plank, served to elevate the drill, and a weight provided the necessary pressure for drilling.



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The Shipshape Home

Electric Fixtures

MY HOME workshop is the major factor in helping to keep my home shipshape. It is the accumulation of years of doing odd jobs and making things for myself. When anything needs doing around the house, I do it myself. If I need some tool, I buy it with the money that will be saved, and when I have the job finished, I have the tool left as profit. By buying tools as they are needed, it is easy to own a fine outfit.

The biggest help to me in keeping the home shipshape is reading POPULAR SCIENCE MONTHLY. It is a regular mine of ideas, aids, and suggestions on how to do almost anything. Friend Wife reads it, too, and evidently with results, for I came home one day and found her calmly screwing back the top of the electric iron. A connection had come loose and she had taken it apart, repaired it, and put it together again. It works fine.

Now I want to pass along to you a couple of ideas that have saved me money.

All the electric fixtures in the house were old when we moved in. They were in good electrical condition, but the outside was spotted and discolored and looked like bad news. A can of flat black paint made them look like the latest thing in wrought iron. The effect was so good that I made some shades from sheet metal and parchment and painted the metal part black to match the fixtures. The picture gives an idea of the effect.

Flat black paint transforms shabby fixtures

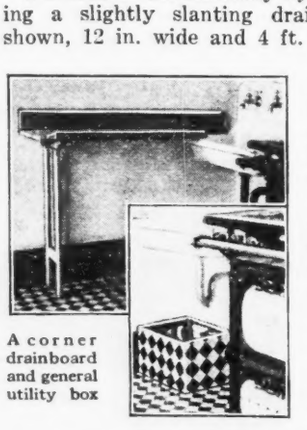
The other idea was to use a broken automobile windshield glass as a shelf for the bathroom. The glass was about 5 in. wide and 30 in. long, with one jagged end where it had broken. I trimmed off this ragged edge, made three wooden brackets, one for each end and one for the middle, and had a cheap plate-glass shelf.—S. B.

You can save money in repairs by taking proper care of your door and window screens. How to do it will be told next month.

Kitchen Improvements

SOMETIMES a kitchen sink is placed in a corner in such a way that no drainboard can be provided without changing the plumbing. This was the case in my own home.

I overcame the difficulty by constructing a slightly slanting drainboard as shown, 12 in. wide and 4 ft. long, with one end cut away so that no part of the sink would be covered. A narrow strip in front keeps the dishes from slipping to the floor, and a wider strip at the rear forms a splashboard to protect the wall from spots.



A corner drainboard and general utility box

The joints were made waterproof by running a piece of tape saturated with white lead where the edges come together. The board was fluted or grooved to improve the drainage. The legs were attached with small angle irons. The whole was finished with several coats of raw linseed oil.

Brushes, cleaners, and soap are kept in a box under the sink. This is a canned-goods box, smoothed with plane and sandpaper on the top edges, and covered on the two exposed sides with a scrap of linoleum left over from the floor. The neat appearance is dependent upon the care taken to match the pattern of the linoleum where the side and end pieces meet.—AUSTIN G. TRIBUTE.

Patching Concrete

OCCASIONALLY it is necessary to repair damaged or cracked concrete work. This is difficult to do successfully unless the following suggestions are observed:

Use the same proportions of sand, gravel, and cement as were used in the original mixture, so that the new work will expand and contract the same as the old concrete. Otherwise the patch will crack.

Keep the place to be patched thoroughly wet for several hours before working on it. This can be done by covering the surface with old sacks well saturated with water. For this reason a rainy spell is a good time to patch concrete, although the work should not be done while the rain is falling on it.

The place where the patch is to be made should be roughened with a hammer or chisel if it is smooth.

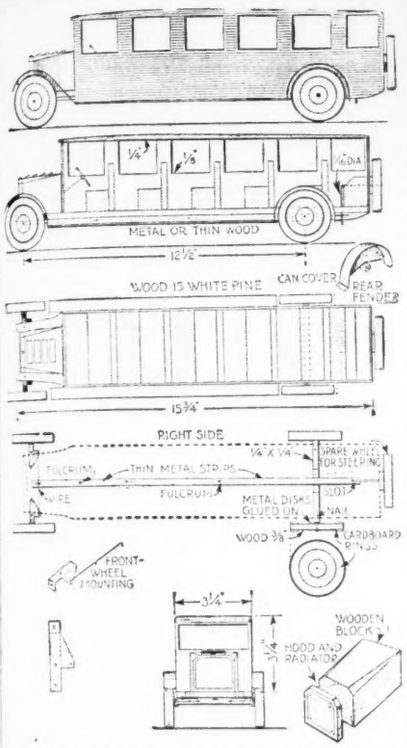
After the patch has been applied, the new concrete should be kept moist and allowed to dry very slowly. This can be managed by covering the concrete with wet sacks, burlap, or rags, or by using moist sand.—M. W. LOWRY, Athens, Ga.

Sturdy Toy Motorbus Has Unique Steering Device

By Donald W. Clark

THIS toy motorbus, which is made mainly of wood, can be built with little difficulty and practically no expense. It has no motor to complicate the construction. The child pushes it around from behind, steering it as he pleases by turning the spare tire, which is ingeniously connected with the front axle.

The accompanying illustrations make clear the construction of the various parts.



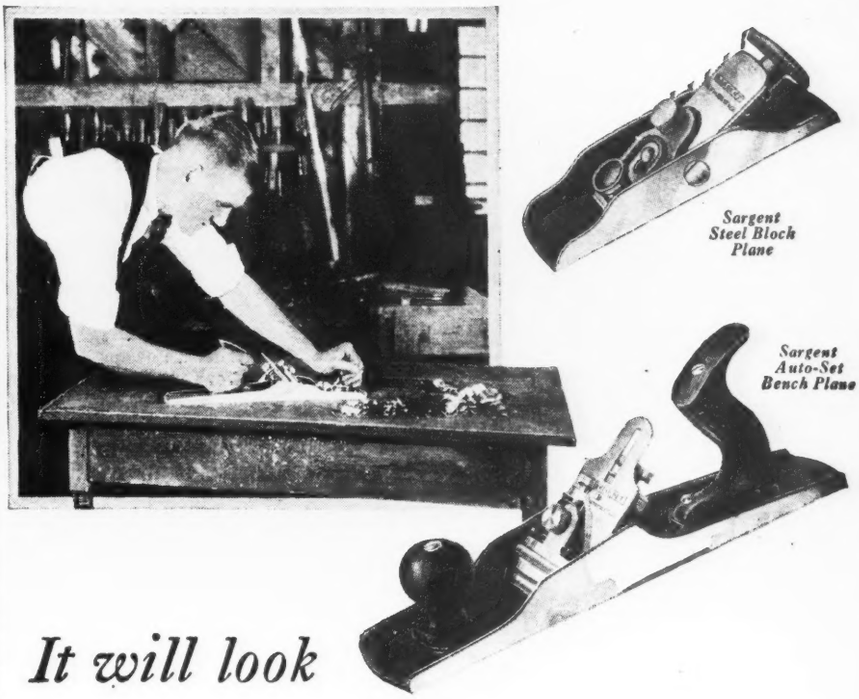
Made of thin wood and painted brightly, this is a toy that will delight little tots

The body is built up of thin wood and the wheels are wooden disks with a cardboard circle glued to each to represent the tire.

Tin covers and strips of tin serve as the fenders and runningboards, and heavy tin or sheet metal is used as shown for mounting the front wheels. The front wheels are connected by a wire bent so that the point in the center projects downward and engages a slot in the first of the two thin metal strips, which serve as steering rods. These strips are pivoted as indicated and are moved by an L-shaped piece of 1-16-in. wire fixed to the center of the spare wheel in the rear. Turning this wheel moves the front axle to the right or left, as desired.

Coming Workshop Articles

HOW to Make Unique Craftwork Dinner Gongs.
Imitating Inlays by Stenciling Woodwork with Sunlight.
How to Store and Care for Your Window Screens.
Constructing a Filing Attachment.
How to Keep Your Oilstone in Good Condition.
Photographic Vignetting Masks Made with Films.



Sargent Steel Block Plane

Sargent Auto-Set Bench Plane

It will look just as good as new!

THIS old kitchen table needs a lot of fixing—but after the Sargent Auto-Set Bench Plane smooths the dented top and trims the battered edges, the job will be nearly completed.

The Auto-Set certainly does fit in at a busy work-bench. It's so capable, keen-cutting, and easy to adjust and handle. It will last for years and years. The special chromium steel cutter is as keen as they come and holds its edge much longer than most. But when it does need sharpening, only a few minutes are required to remove, whet and replace it. You don't have to touch the original adjustments.

For the smaller jobs, for the finishing touches to cabinet work, or for getting into close quarters, you'll need the Sargent Steel Block Plane. This is small in size, but big in ability. The low angle arrangement of cutter makes it particularly suitable for cross-grain work and rough or knotty surfaces.

Both of these Sargent Planes are used everywhere by carpenters who take pride in the character of their tools. Write for Plane Booklet.

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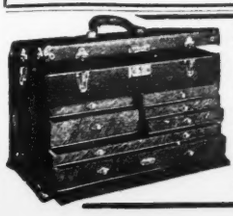

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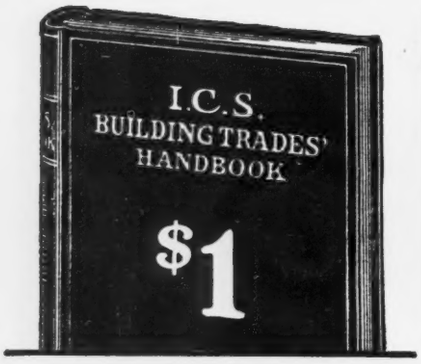

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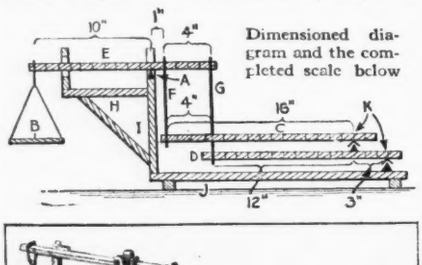
Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

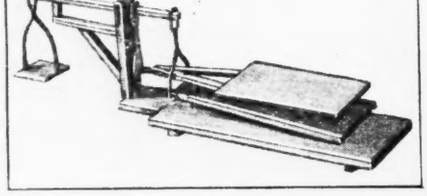
ACCURATE scales are expensive to buy and quite difficult to make by the ordinary method. A delicate balance is essential, nevertheless, as soon as really careful chemical work is to be done in the home workshop. The question is, how to make a dependable scale cheaply and without taking a great deal of time.

My best suggestion in answer to this question is the construction illustrated below. I am sure that the many readers who have shown their interest in the Home Workshop Chemistry series by writing to me about this and other questions will find such a scale simple to make and adequate for all ordinary requirements. It will weigh light as well as heavy objects.

The scale can be made from metal or wood strips, thin boards, wire, tin, and



Dimensioned diagram and the completed scale below



three safety-razor blades or old knives. It should be made accurately, for a slight error will throw the entire balance out of order.

The dimensions are in inches. If a smaller scale is desired, each inch can be divided into halves, taking a half inch as the unit of measurement. The scale should not be made smaller than half size.

The scale shown consists of a base 22 in. long and an upright about 10 in. high. The base and upright must be firm.

The top of the upright carries a razor blade, *A*, firmly fastened in position, edge upward. On this is placed a wooden rod, *E*, that is 16 in. long and about ½ in. square. A tin U or V is fastened to the rod ½ in. from the end to carry the weight pan and 10 in. from this point another V of tin is fastened, this time on the under side. This V rests on the knife *A*. One inch from this point another V is fastened on top of the rod, while 4 in. from this last point another and final V is attached. These V's are bent from tin and nailed to the long beam.

The baseboard has a razor blade placed 20 in. from a line drawn vertically through the knife of the upright. This

(*Continued on page 109*)

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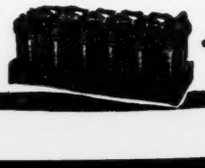

Old Table Leaves Utilized in Building a Bookcase

HAVING a number of old table leaves, we sawed off the little knobs, poured wax in the depressions and used the pieces to build book shelves as shown. They were enameled black and decorated with bright flowers. These were painted on the black surface in such a way that tiny buds concealed the wax depressions where the knobs on the edge had been removed.—M. L. CHERRY, Sandusky, Ohio.

Home Workshop Chemistry

(*Continued from page 108*)

blade supports a tin V placed 1 in. from the lower end of the bridge, *D*, which is a board 17 in. long. Exactly 15 in. from this point another V is placed on the under side of the arm and it is connected with the beam by a wire arm, *G*.

The upper bridge arm or weighing platform, *C*, is a board 19 in. long. It is balanced by a knife firmly fastened to bridge *D* exactly 3 in. from the end knife, as at *K*. A V is used here as in the former cases, and another V is fastened to the weighing platform, 16 in. away. This V is connected by means of wire *F* to the V on arm *E*.

The scale pan, *B*, is fastened to beam *E* by means of the V at its far end.

The support, *H*, prevents the beam from swinging too much and indicates when the scale and the pan are balanced. The swing should be very small, not more than $\frac{3}{8}$ or $\frac{1}{2}$ in.

The length of the two wire arms *F* and *G* are determined by the height of the upright and the height of the knives. The arms *E*, *D*, and *C* must be perfectly horizontal or the scale will not work properly.

To balance out the scale, add slight weights to either scale pan *B* or bridge *D*, so that beam *E* is in equilibrium. Then if 1 gram is placed in *B*, 10 grams will be balanced at *C*. This means that a weight placed at *B* will balance another weight at *C*, which is just 10 times as heavy. By reversing the process and placing the weight on *C* and the object to be weighed at *B*, the object will be exactly one-tenth the amount.

The decimal arrangement gives a flexibility to the scale that is desirable in the home laboratory. The necessary weights can be purchased from any scientific druggist supply house. Your own druggist usually will be glad to get them for you.

PUTTY may be kept soft by covering it with water. To prevent the water from evaporating, add a few drops of lubricating oil. This will form a surface film.

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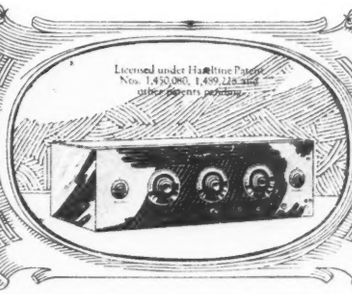

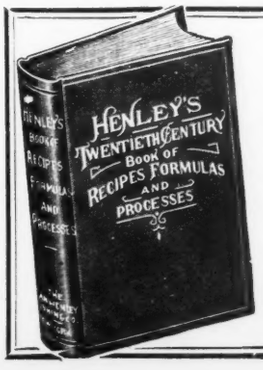

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How to Aline Auto Engine Connecting Rods

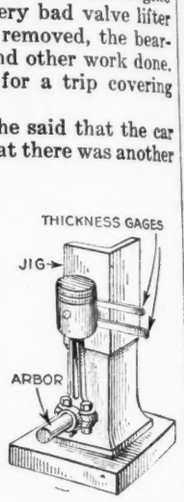
By Ray F. Kuns

Principal, Automotive Trades School, Cincinnati, Ohio

A MOTORIST brought his car into the shop not long ago and complained about the noise made by the valve lifters. He asked that the engine be gone over. One very bad valve lifter with a flat roller was removed, the bearings were taken up, and other work done. The owner then left for a trip covering several states.

When he returned he said that the car had run nicely, but that there was another bad lifter noise.

"The first 200 miles I drove as you told me, at not more than 25 miles an hour," he explained. "After that, I speeded up a little and then I noticed that the old lifter noise was back. It doesn't seem to do any harm, but I do not like the noise. I want to leave the car and have you put in another new lifter."

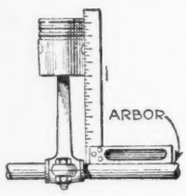


Checking alinement on special jig

A mechanic found that the lifters were all right, although the owner could be excused for the mistake, since the noise was practically the same as the first one he had experienced.

The repairman decided that it was a wristpin knock, and so it was, but not due to a loose pin. In doing the engine overhaul work the first time, the rod in No. 2 cylinder had been sprung out of line or the bearing improperly scraped. At any rate, the rod set at an angle rather than plumb, and when the explosion came, the upper end of the rod was snapped out against the piston boss, producing a knock. This is the sort of noise hard to find and only one of the troubles likely to be experienced when piston rods are not properly alined.

Rods are thrown out of alinement when pistons are removed from the cylinders or other work is done on them. They always should be put on an alining jig or tested by other means before being replaced in the engine.



Using square to test straightness

Several methods of alining rods may be used when a jig is not available. A square set on the machined top of the crankcase and along the skirt of the piston when the piston is on dead center will indicate the degree of misalinement. Another way is to clamp the rod bearing on an arbor and use the square to test the skirt.

A splendid method of testing the piston and rod assembly in relation to the cylinder is to assemble the job with the piston in the cylinder, but without the

(*Continued on page 111*)

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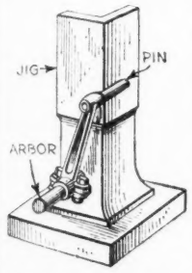
How to Aline Connecting Rods

(*Continued from page 110*)

rings. Have the cylinder head removed and hold an electric light under the cylinder to be inspected. If the rod is properly alined, it will be possible to see a ring of light all the way around the piston in the cylinder. If the rod is misalined, the piston will be cocked in the cylinder and it will be impossible to see past it except at certain points where it is not binding.

When a rod is not properly alined it must be bent or sprung until it will allow the piston to fit the cylinder correctly. Otherwise the cylinder will wear unevenly. In bad cases it will be scored by the piston, and bearing trouble will develop at both ends of the rod. The piston pin is far more likely to be loosened from its anchorage, and piston pin scores result.

Merely bending the rod will not always aline it and the piston. In some instances it is necessary to give the rod a slight offset by making two bends. A large monkey or adjustable wrench is the usual tool used for correcting rod trouble of this sort. Determine which way and how much the job is out, and apply the wrench to spring the rod. After carefully alining and testing outside the engine cylinder, it is wise to make the lamp test as a final check.



Checking parallelism of rod journals

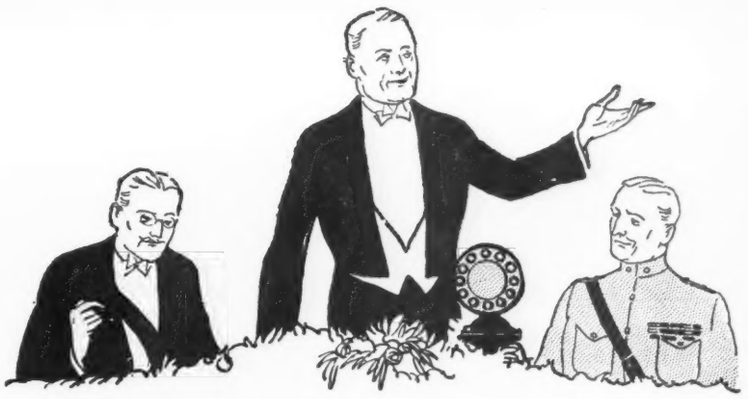
When scraping rods, many mechanics prefer to get their final impression on the rod bearing by bluing it and rotating the shaft while the piston is in position in the cylinder. This frequently will show the workman that he has not scraped the bearing evenly and tell him just where to apply the scraper.

Another essential test in alining a rod is to see whether the axis of the pin and the shaft journal are in the same plane. If they are not, there will be a twisting and binding movement imparted to the piston as it is moved up and down. The piston should be removed from the pin and the pin replaced in the rod.

By clamping the rod on an arbor, it is possible to sight the pin and arbor and get an approximate alinement. The best practice, however, is to use an alining jig that has parallel surfaces that the pin must strike when the bearing end is clamped on the fixed arbor.

Workmen sometimes feel that because care has been used in disassembling and reassembling, things must be right. Factories long since have learned, however, that, no matter how carefully parts are machined and fitted, every possible test must be made for alinement. Just such methods as described and illustrated here are used to provide the quiet, efficient motors turned out in automobile factories.

THE next article in Mr. Kuns' series for the motorist who makes as many of his own repairs as possible will be on fitting new piston rings.



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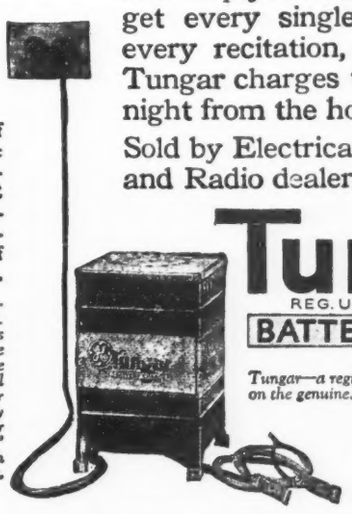

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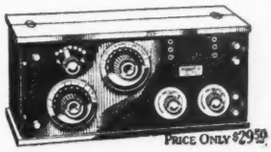

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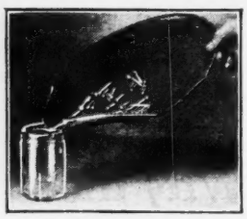
Homemade Metal Tray Aids in Sorting Screws Quickly

IN LOOKING for odd size screws or other small parts in a miscellaneous assortment, much time often is lost in returning the collection to its container, and frequently shavings and dust are swept from the bench top into the container along with the screws. These difficulties are overcome by using a pan of the shape shown. Screws may be spread on it and when those of the right size have been found, the remainder can be poured back into the container with one rapid motion.—C. E. WEIBEZAHL, Syracuse, N. Y.



Replacing screws in glass jar container

How to Construct a Jointer

(*Continued from page 80*)

chase a knife such as that shown in detail *D* at a low price, so that it would hardly pay to take chances of losing a homemade knife while tempering. If the safety head is used, the knife blades will come as part of the head.

The four holes drilled through the bottom members and marked *F* are used for fastening the machine to the bench. A hole about 6 in. square is made in the top of the bench to allow the shavings to drop to the floor.

The motor may be located beneath the bench and the belt brought up through another hole large enough for it to pass. While I have not shown a loose pulley on the countershaft, it would be an easy matter to put one on and, as the driving pulley for the head is on the outside of the side members, a belt shifter could be attached directly to the bottom member to which the countershaft bearings are fastened.

The 2 by 1¾ in. flanged pulley should be keyed to the shaft, as it would be impossible to get more than one setscrew in the pulley. The key need not be larger than 3/16 in. square, but should be well fitted and driven home snugly. The same is true with reference to the countershaft pulleys. Care should be taken to see that the pulleys are true and well balanced.

One point in regard to the wedges used for raising and lowering the table should not be overlooked. They should be made so that the grain of the wood runs with the wedge edge. This will prevent rough edges from rubbing together. The surface should be well greased.

Before starting the machine, see that it is thoroughly oiled. Use an endless belt, as a laced one running at this speed will cause a great deal of vibration and in time tend to loosen parts of the machine. It is very important to bear in mind that the table and cutter head must be true with each other in order to do perfect work.

If reasonable care is taken in purchasing the materials, one should be able to build this jointer, I estimate, for about $30 and have a machine that with care should last a lifetime.

A Vertical "B" Battery
Upright in Shape —Upright in Use

WHERE weight, table or cabinet space is a factor in your selection of Burgess Radio "B" Batteries, buy the Burgess vertical "B" No. 5158.

It is right at home in any position in your cabinet. Its sturdy compactness is almost a necessity in portable receiving sets.

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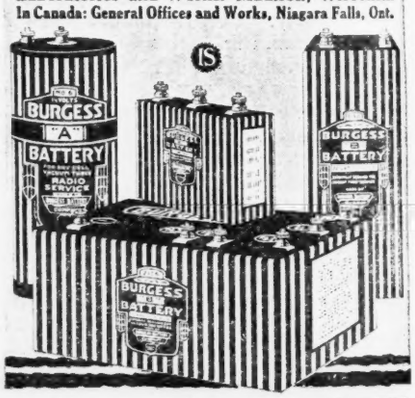

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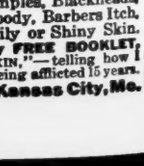

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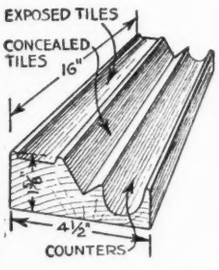
Improved Combination Racks Aid in Playing Chinese Game

By S. W. Blanchard

HAVING experimented with several different types of accessories for the now popular Chinese game, I evolved a design of rack that not only holds the concealed tiles, but also the exposed portion of the hand, as well as the counters. These combination racks make unnecessary any other equipment and are preferable to those built into the edge of a special game table because they are portable. They also serve as straight edges in building the wall of tiles straight.

The racks are made as shown from any clear grained, soft wood. A combination plane is the best tool to use, but they may be made with gouge, chisels, and an ordinary plane.



Combination rack

If you are near a planing mill, you will find it economical to have the mill pick out some knives that will cut a molding to the design of this rack, or very close to it, and have sufficient molding machined to make several sets, each of which will require 6 lineal ft. The molding, whether hand or machine made, is sawn up into 16-in. lengths.

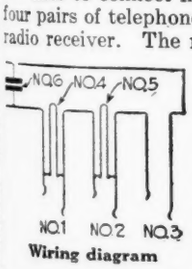
A pleasing finish is obtained by giving each rack two coats of black shellac, each lightly rubbed down with very find sandpaper and oil, and two more coats of plain shellac, also rubbed down. Red initials representing the winds are painted on each rack in Chinese style.

Black shellac may be made by mixing dry powdered lamp- or bone-black with alcohol, being sure that there are no lumps, and then adding thick shellac to the mixture. There should be enough black in the mixture so that the shellac is perfectly opaque.

A good profit may be made by disposing of the racks to friends, or the sets may be used as gifts.

Connecting Radio Jacks for Several Head Sets

BY USING radio jacks I have been able to connect instantly as many as four pairs of telephone head sets with my radio receiver. The method is shown in the accompanying diagram. Numbers 1 and 2 are double - circuit jacks, of which there can be as many more as desired. Number 3, or the last jack, is a single-circuit.



Wiring diagram

Solder together the center springs of the double-circuit jacks, as at Nos. 4 and 5. If the circuit calls for a telephone condenser, place it ahead of the jacks, as at No. 6. A double-circuit jack may be used at No. 3, but the center spring must be left open.—THEODORE ENGEN.

When you stop for the night

Throw up an aerial and tune in just as if you were at home

THERE is no reason why you should deprive yourself of radio entertainment when you are away on a vacation. If your home set is too large and bulky, you can easily build a small vacation set you can carry anywhere.

The cost of your vacation set will be comparatively small. The battery of your car will furnish the necessary electrical current, and if you have a home set you can take a tube and the "B" batteries from that.

You should use the same care in selecting parts of your vacation set as you used when you built your home set. Buy dependable instruments and then mount them on a first-class panel.

Use a Celoron panel and you help your instruments do their best work.

Celoron, a bakelite material, is one of the finest insulating materials known. It has high dielectric strength and great resistance to atmospheric attacks. You can drill it, saw it, tap it, and bore it—and it does not buckle, warp, or crack. It is practically indestructible.

Celoron panels have been approved by the U. S. Navy and the U. S. Signal Corps. They are used by the best radio manufacturers and by thousands of radio fans.

You can buy Celoron Radio Panels in three beautiful finishes—black, oak, and mahogany. These do not lose their lustre or become discolored.

Practically all good dealers handle Celoron Radio Panels.

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Cunningham 40-page Data Book fully explaining care and operation of Radio Tubes now available by sending 10c in stamps to San Francisco office.

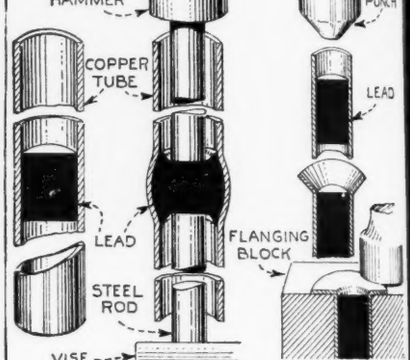
Home Office: 182 Second Street, San Francisco — C. J. Cunningham Inc. — *Branch,* Chicago *Branch,* New York

Tricks that Aid in Shaping Brass and Copper Tubing

COPPER tubing can be shaped in various ways if one knows how to do it. Brass tubing—that is, drawn-brass tubing—can be handled in the same way, to some extent, but it will not stand as much stretching and bending as copper.

Before starting, anneal the tube thoroughly by heating it red hot and quenching in cold water. If there is much hammering or forming, anneal it at intervals during the process.

A job that looks difficult, but is not particularly so, is making a bulbous enlargement in a tube. Plug the tube with lead at the place where the enlargement is to be made, either by pouring in melted metal or by driving in a cylindrical plug, and then force the soft metal outward by pressure against the ends of the lead plug. The simplest way to apply pressure is to slip the tube over a steel rod held firmly in a vise, and insert a similar rod through the other end, using the upper rod as a punch. The lead is removed after the job is done by melting it out. This cannot be done where the tube is too long.



How a bulbous enlargement is formed, and a simple method of making a flange

It is a good idea to fill a tube partly with melted lead or Babbitt metal when flanging an end, chiefly because it prevents the tube from becoming deformed just back of the flange. Leave enough of the tube free of lead to allow the flange to be turned over. In a piece of brass or iron drill a hole into which the tube will fit tightly, and see that the hole is square with the surface of the block. Start turning over the flange by belling out the end of the tube with a conical punch, and then use a round-ended punch and the drilled block to carry the work along. Finally flatten down the flange on the block with the hammer.

In the last stages of the work re-annealing will probably be necessary. While this will melt out the lead filling, it will not matter, because the tube will be supported by the block. Do not expect to be able to make a wide flange at the first attempt. A good idea is to split the die-block so that when it is gripped in the vise the tube will be nipped and held securely.

Bending can be done perfectly, no matter how complex the bends, if the tube is filled with melted lead; the tube will bend like a soft rod and will not flatten nor buckle.—H. G.

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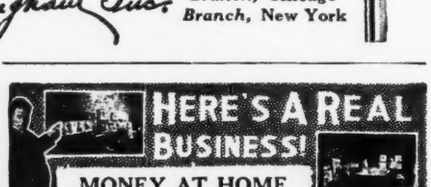
offer you a **wonderful opportunity.** Wrestling is easily and quickly learned at home **by mail.** Men and boys write **now** for **splendid free book.** Learn all the science and tricks. Be able to handle big men with ease. Accept this wonderful offer **NOW. Send for free book today,** stating your age.

Farmer Burns School of Wrestling, 1786 Range Bldg., Omaha, Nebr.



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Start permanent business. Everything furnished. Work anywhere, only table room required, $25.00 to $75.00 weekly operating Tangley Art Portrait Landscape Painting Business. No experience necessary. Hundreds successful workers. Quickly learned in 10 lessons. Free booklet.

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$ Only 9 85 DOWN Improved New Model

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You can get any size OTTAWA from my factory at lower prices and on easy monthly payments. Earn its cost as you use it.

NO INTEREST TO PAY 30 days **Free Trial** on your farm. Thousands in use today. Easy engine to start. Sizes 1½ H-P to 22 H-P. Write for new **FREE Book**—"How to Know Better Engines." Send name on card today.

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Protection against Burglars, Tramps, & Dogs

PRICES 50c $1.00 POST-PAID

Well made and effective; modelled on latest type of Revolver; appearance alone is enough to scare a burglar. When loaded it may be as effective as a real revolver without danger to life. It takes standard .22 Cal. Blank Cartridges obtainable everywhere. **Price 50c. Superior quality $1.00 Postpaid.** Blank Cartridges, by express, 50c per 100.

Johnson Smith & Co., Dept. 157, Racine, Wis.

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SCREW CAP ABSOLUTELY NON-LEAKABLE
PEN RETAINER FITS INTO BARREL FRICTION-TIGHT PREVENTING TWISTING OF TUBE
ITS THE POINT.
HAS EIGHT GROOVES FOR INK TO FEED

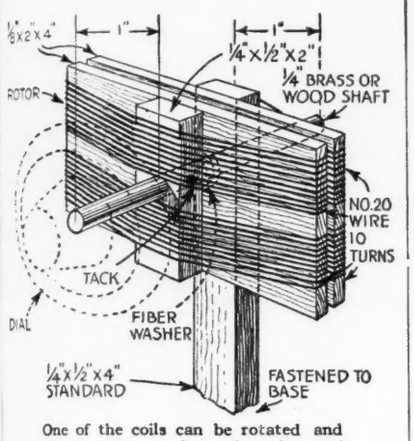
Imported from Japan. "It makes Carbon Copies." Guaranteed for 1 year. Hustlers Making $20 Daily! Money refunded if you don't think it's the best pen you ever wrote with. Up to 150 per cent Profit. Send for quantity price list and distributing plans. **F. SPORS & CO., 199 S. 4th St., Lesueur Center, Minnesota**

Unique Variometer with Flat Coils Allows Close Tuning

TWO thin boards serve as forms for the coils of the simple variometer illustrated, which can be made at practically no expense and yet gives exceptionally sharp tuning.

A small block is glued across the rotary board, and the stationary board is fastened by means of another block to the baseboard of the receiving set behind the panel. A wooden or brass shaft 3½ in. long passes through both boards and is pinned with a nail or tack to the one that is to turn. A fiber washer separates the two boards.

Around each is wound 20 turns of No. 20, 22, or 24 single or double cotton-



One of the coils can be rotated and also moved away from the other coil

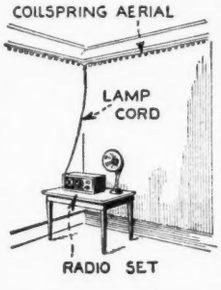
covered wire, 1 turns each side of the shaft. The coils are connected in series with a flexible connector and a flexible lead is provided for the wire from the rotor.

The variometer is used as any other variometer, the knob being turned to the right or left to tune. For still sharper tuning, the knob is pulled out so that the coils are separated more than normally, the shaft having been made long enough to allow 1-in. motion in and out.

The same idea can be applied in the construction of a variocoupler and for various other uses in building experimental receiving sets, and various refinements can be made, such as providing a stop for the rotor, impregnating the wood with hot paraffin before winding the coils, and using hard rubber or fiber in place of wood.—JAMES GREENWOOD, Dunbar, Pa.

Coilspring Serves as an Aerial

MOVING to an apartment recently, I found I could not erect an outside aerial for my radio receiving set. I used, instead, an indoor aerial composed of two lengths of No. 22 hard brass wire, each 50 ft. long. The wire was wound into a spring ½ in. in diameter and strung from opposite corners of the room, as shown, being fastened to the molding with fiber hooks and insulators.—W. H. F.



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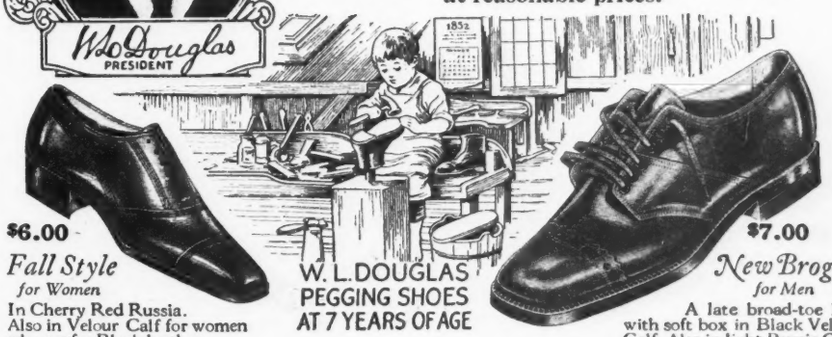
BOYS AT $4.50 & $5.00

Women of fashion should know that we have in our stores a most attractive display of distinctive, up-to-date Women's shoes in exclusive styles which appeal to those who desire stylish and comfortable shoes at reasonable prices.

W. L. Douglas PRESIDENT



$6.00 *Fall Style for Women*
In Cherry Red Russia. Also in Velour Calf for women who prefer Black leather.

W. L. DOUGLAS PEGGING SHOES AT 7 YEARS OF AGE

$7.00 *New Brogue for Men*
A late broad-toe last with soft box in Black Velour Calf. Also in light Russia Calf.

WEAR W. L. DOUGLAS SHOES AND SAVE MONEY

FOR 38 YEARS, W. L. Douglas' name and portrait have stood for quality, for economy and for satisfactory service. W. L. Douglas shoes are exceptionally good values. Only by wearing them can you appreciate their superior qualities. ***Such quality, comfort and service are rarely found in other makes at our prices.***

THE EXCLUSIVE, smart models, designed especially for young men and women, are the leaders. ***Seldom have you had the opportunity to buy shoes of such wonderful value as you will find in the W. L. Douglas $7.00 shoes*** in our retail stores in the principal cities, and in good shoe stores everywhere.

WHEREVER YOU LIVE, demand W. L. Douglas shoes. They are sold in 120 of our own stores and by over 5,000 shoe dealers. For economy and dependable value, ***wear shoes that have W. L. Douglas' name and the retail price stamped on the soles.*** The stamped price guarantees the value. If they are not for sale in your vicinity, write for catalog.

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A new puncture-proof inner tube has been invented by a Mr. M. E. Milburn of Chicago. In actual test it was punctured 500 times without the loss of air. This wonderful new tube increases mileage from 10,000 to 12,000 miles and eliminates changing tires. It costs no more than the ordinary tube. Mr. Milburn wants them introduced everywhere and is making a special offer to agents. Write Sales Manager, J. S. Hansen, 336 West 47th St., Chicago.

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If you *never read a musical note in your life*--if you haven't even the slightest knowledge of music, we can quickly and positively teach you to play this wonderfully popular instrument. Don't be just a "listener" when you can *easily be the center of interest* among your friends. **Over 40,000 successful students.**

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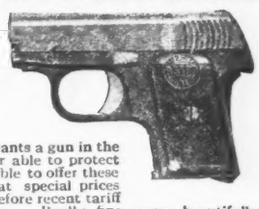

Nearly every man wants a gun in the house—he feels better able to protect his family. We are able to offer these Genuine Astra guns at special prices because we bought before recent tariff raises became effective. Really fine guns, beautifully finished, hard hitting. Use standard ammunition. Order direct from U. S. importers

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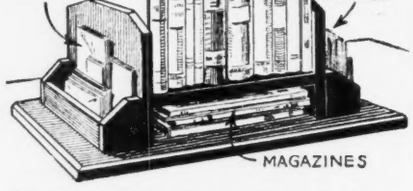
Bookrack Has Compartments for Paper and Magazines

FOR a flat-top desk or a library table, the combination rack illustrated has the advantage that it holds not only books, but also magazines, note-paper and current correspondence.

The original was made of walnut to match other furniture, but any wood may be used. The materials required are as follows:

1 pc. ¾ by 10 by 22½ in. for the base
1 pc. ¾ by 8 by 13 in. for the shelf
2 pc. ¾ by 8 by 10¼ in. for the uprights
4 pc. ½ by 2¼ by 4½ in. for the pocket sides
2 pc. ½ by 2¾ by 7 in. for the pocket ends

To simplify the assembly, screws are used wherever possible. The shelf is



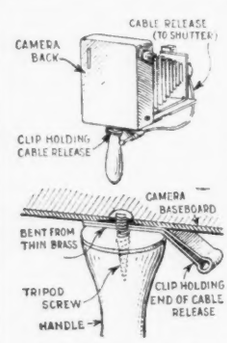
By changing the shape of the end pieces many variations of this bookrack are possible

screwed to the two uprights, the screws being placed so close to the edge that the pocket ends will cover them, and the heads are countersunk. The uprights are screwed to the base. The pocket ends are nailed to the sides and the nails are set a trifle so that the holes may be filled with colored putty. The pockets then are fastened to the base and to the uprights with screws.

The design may be varied in many ways without changing the construction. The top of the uprights may be rounded or given as decorative a profile as the maker wishes, and then the upper edges of the pocket ends may be modified to harmonize with them.—C. A. ROSELL.

Handle for Holding Camera

IT IS difficult to hold hand cameras, especially those of small size, perfectly steady while a comparatively slow snapshot is being taken. By adding the handle illustrated, however, the photographer can get a good grip on the camera with one hand only.



This insures a good grip on the camera

A tripod screw, one end of which is a wood screw, is fitted into a file handle and a washer is fastened on the end of the handle. If no such tripod screw is available, an ordinary woodscrew can be cut down and one end threaded to fit the tapped tripod hole in the center of the camera baseboard.

If a wire release is fitted to the shutter, the finger end of the release can be held in a small clip bent from brass sheet and held, as shown, between the camera and the handle.—C. A. OLDROYD.

Are You the Type Who Must Fear Old Age?

By Byram C. Kelly

Science now knows that seven men out of ten must fear a serious condition that comes at middle age. Here is a situation that you must face—a test that every man should make before it is too late.

I am past 40 myself. I had begun to wonder when I would begin to break—to lose my old-time pep and aggressiveness—when, through a mutual friend I made the personal acquaintance of a certain member of the American Association for the Advancement of Science, whose wonderful work I had heard of. I made a trip to his laboratories and the things I learned should interest every man approaching or past the prime of life. Surprising as it may seem, nearly two-thirds of all men past a certain middle age suffer with a disorder of the prostate gland.

Common Middle Age Ailments

Here is an important cause for many conditions which heretofore have been taken for granted as old-age ailments—sciatica, aches in back, legs and feet, frequent nightly risings, nervousness and irritability, and frequent dizzy spells, indicating high blood pressure. Constipation, headaches and depressed spirits often go along with it. But my visit would have been in vain had I not learned of an amazing treatment that relieves prostate trouble—a treatment that reaches this gland directly—and is so convenient that anyone can apply it in his own home.

10,000 Men Find Relief

I know too plainly the effects of prostate gland disorder when it is allowed to continue unabated. I know of the operations and the common saying among many that the average life after this operation is only two or three years. That is why I am doing everything possible to let people know of this important discovery. Statesmen, bankers, lawyers, doctors, men from every walk in life have used the method with success. I have read hundreds of letters from gratified men. One I remember in particular was from a Colorado man which says, "73 years young is my age. Yet for years I suffered with prostate trouble. Used medicine to no avail—had about given up hope when a doctor recommended your treatment." Just think of a man 73 years old restored to the health and buoyancy of youth—without drugs, electric rays or books.

All Explained in Free Book

If you have prostate trouble, if you suffer with any of the ailments mentioned above, you should not lose a day in finding out about this wonderful new method. Send immediately for an interesting, free book called, "Why Many Men Are Old at 40." It describes this splendid treatment and shows you how you may regain much of your youthful vigor. Send your request to the Electro Thermal Company, 0000 Main Street, Steubenville, Ohio, the concern that is distributing these books for the author. There is no obligation. If you are not interested yourself, you may be able to do an "older" friend an immeasurable benefit by showing him this article. Mail the coupon.

The Electro Thermal Company,
4037 Main Street, Steubenville, Ohio

Please send me, free, without obligation, the booklet, "Why Many Men Are Old at 40."

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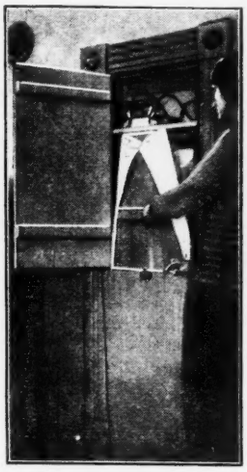
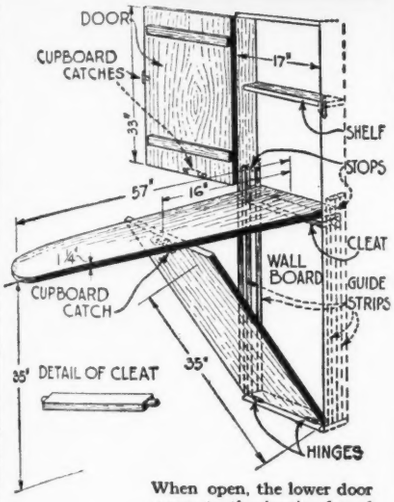
Built-In Ironing-Board Has Strength and Simplicity

THE folding ironing-board and cupboard illustrated is of very solid and simple construction. No braces are required to support the end of the board and therefore there is nothing in the way on the under side.

The method of building the cupboard, which may be installed in an old as well as in a new house, is made clear in the accompanying drawing. The dimensions, of course, may be varied to suit the builder, but those indicated have been found satisfactory.



The cabinet is the depth of the wall studding. It is lined with ¾- or ⅞-in. lumber on the top, bottom and sides; the back is a sheet of neatly fitted wallboard. The



When open, the lower door supports the ironing-board

casing around the cabinet matches the trim around the kitchen doors and windows.

Two doors for the cabinet are provided. The top door is opened first. The board itself then is grasped and pulled upward until the end cleat reaches the stops on either side. Next, the lower door is swung out and the board is let down on it.

A shelf is provided near the top of the cabinet for the iron and rest when they are not in use. When an electric iron is used, the plug may be put in the wall of the cabinet.—HAROLD J. BAKER, Port Huron, Mich.

Metal Edging for Woodwork

ROUGH wooden edges sometimes can be finished cheaply and effectively with metal conduit molding, obtainable from electrical supply dealers. I used it recently when building a box for the back of a delivery auto.—O. A.

5-Room $ ALADDIN 548 We Pay the Freight

You can buy all the materials for a complete home direct from the manufacturer and save four profits on the lumber, mill-work, hardware, labor.

Price includes all lumber cut to fit; highest grade interior wood work, siding, flooring, windows, doors, glass, paints, hardware, nails, lath, roofing, with complete instructions and drawings. **Freight paid** to your station. Permanent Homes—NOT PORTABLE. Many styles to choose from. **Write nearest mail today for FREE Money-Saving Aladdin Catalog No. 1067.**

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Large living room, kitchen, 3 bedrooms, large veranda—an ideal place for outdoor dining-room or sleeping quarters. Summer cottage price includes lumber cut-to-fit ready to nail in place, windows, doors, hardware, nails, roofing, paint, etc. Freight paid to your Station. Write today for Summer Cottage Booklet No. 1095.

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Heat, plenty of it, in base burner or heating stove. Clean, satisfactory, economical, convenient as steam heat. Brings happiness, plus.

Convert any cook stove, range or heater into a real gas stove. OXO-GAS, the cheapest, cleanest and most efficient fuel known to science, is made right in your own stove from kerosene or distillate and air. Burns a pure, blue flame of high heating intensity as silently as city gas.

Send for catalog illustrating and describing twenty different, distinctive designs of oil burners for *Furnaces, Cook Stoves, Heating Stoves, Base Burners, Hot Water Heaters, etc.*

AGENTS WANTED Some choice territory for OXO-GAS agencies still open to thoroughly responsible parties. Your own locality may yet be unassigned.

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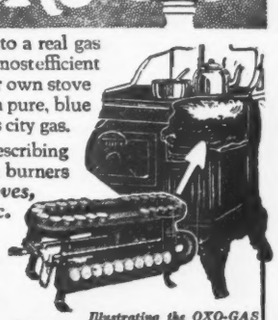
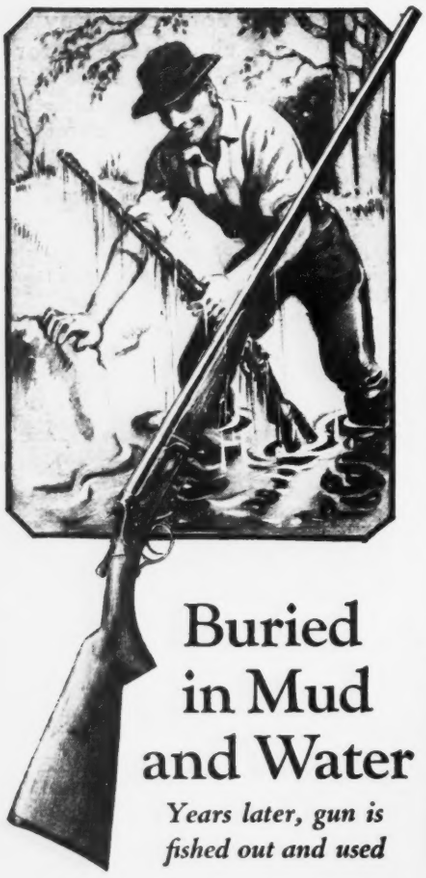


Illustrating the OXO-GAS Burner in cook stove, installed in a few minutes, lasts a lifetime, pays daily dividends in saving health and happiness.



Buried in Mud and Water

Years later, gun is fished out and used

A GUN may be down, but it's never out. At least that's what John R. F. Workman, of Montana, thinks of the Iver Johnson. Read what he says:

"I have one of your shot guns which I recovered from a deep hole in the bed of a lake, after being buried in mud and water for a number of years. This gun was in perfect shape with the exception of the mainspring, which broke while I was cleaning it. Inside, the barrel is as perfect as if made last week."

Iver Johnson Champion Single Barrel Shot Gun

Barrel and lug of high carbon steel, forged in one piece. Barrel full choke which assures close, hard shooting. Adjustable mainspring tension bar; compensating locking bolt which automatically takes up wear; safety rebounding hammer; piano wire coil springs, heat treated, where necessary; real black walnut stock and trap style forend beautifully finished; genuine hard rubber butt plate. Various gauges and styles —including the Matted Top Rib and the .410.

Send for Free Booklets

Catalog "A" illustrates and describes Iver Johnson Champion Single Barrel Shot Guns, Hammerless Double Barrel Shot Guns and the famous Iver Johnson "Hammer the Hammer" Safety Revolvers.

Catalog "B" describes Iver Johnson Bicycles for men, women, boys and girls; also Velocipedes for little children.

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5 River Street, Fitchburg, Mass.
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San Francisco: 717 Market St.

IVER JOHNSON SHOT GUNS

Your Tools and Their Care

(*Continued from page 77*)

take the temper out of as thin-edged a tool as a chisel?"

Here Old Prentiss picked up a piece broken from a very thin screwdriver. Striking a match, he put the tip of the screwdriver in the flame. It was but a few seconds before the color began to run.

"There, you see," said Old Prentiss, "we have a piece of soft steel—done with a match, too! You don't require a forge to develop heat enough to draw the temper of a tool. Now, if a match will do this, you can imagine what a grinder will do. Don't take too heavy a cut or bear down too hard on the wheel, and dip your tool in water very frequently.

"And here's a hint about gouges. I saw Jim trying to sharpen a gouge on a straight-faced wheel. It can't be done—at least, not by the average mechanic. There are wheels for the purpose, as well as emery sticks and stone slips for finishing up in place of the usual oilstone."

I thought the old fox had run out of opinions on the subject of grindstones,

Hitting a hammer handle violently to draw a stubborn nail often snaps the wood in two

oilstones, and sharp-edged tools, but just then his eye fell upon a hammer with a chipped face. He was off on a new line.

"Now, what do you suppose does that?"

I guessed that it was probably a poor hammer. Jim had the idea that it was the sign of old age. We were both wrong.

"The fellow who put the handle in this hammer didn't know his job," said Old Prentiss. "You see, the face of this head slants up instead of down. Now, when you swing such a hammer on the arc of a circle, as you do when hammering anything, you hit high, with the result that some hard blow on such a thing as a cold chisel, striking off center, will knock off the edge.

"Several years ago I had the job of cutting the keyway in a 24-ft. flywheel. The key was 3 ft. long and 1½ in. deep at the big end. It took me two days to do it but, although I chipped every bit of that metal out with hammers and cape chisels, I had neither mashed fingers nor a smashed hammer. Whereas, if the hammer had been hung like this one, I might have had both—and still be at the job! Now, if you have occasion to put a handle in a hammer, get it right. Don't have the head at right angles to the handle, but have it turned down slightly at the face.

"Then, too, use a hammer as one is sup-

(*Continued on page 119*)

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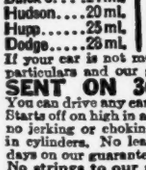

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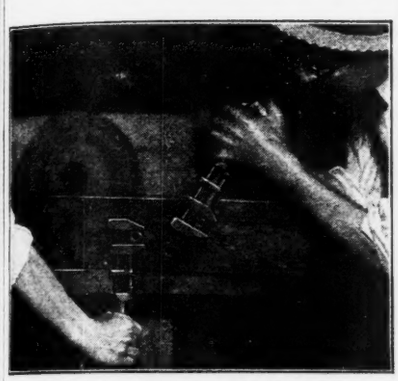
Your Tools and Their Care

(*Continued from page 118*)

posed to use it. The side of the eye was not meant to be used as the face, nor was a hammer meant to be used as a mallet when chiseling, nor the ordinary claw-hammer as a hatchet for ripping apart boxes, and things of that sort. You wouldn't expect to use a little bit of a clawhammer to pull a large spike. Get a nail-puller for that purpose; you will save in the long run.

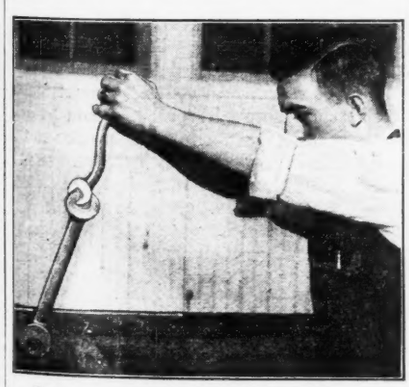
"Only the other day I was speaking to a manufacturer of hammers and he told me



A wrench is turned as at the right, and not pulled backward, as at the left

that one of his products came back from a carpenter who had used it for 17 years. While the quality of the hammer undoubtedly had something to do with it, I am sure the most important thing was the care the owner gave it.

"Speaking of hammers," Prentiss went on; "a monkey-wrench never was designed to take the place of one. It was meant to be used to turn nuts only. In using a monkey-wrench, the jaws always should face in the direction in which the wrench is to be turned. If the jaws face in the opposite direction, the tendency is for the jaws to spread. This puts an additional strain upon the weakest part of



Exaggerated for emphasis, this illustrates one of many ways in which wrenches are abused

the wrench. Moreover, by using in this way, it may cause a slipping of the nut, and that damages both nut and wrench.

"It frequently happens that a nut is to be turned with an open-end wrench and that none can be found that fits exactly. I have seen men try to drive the next smallest size wrench down on the nut with a hammer. This not only spreads the

(*Continued on page 120*)

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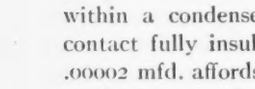

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Your Tools and Their Care

(*Continued from page 119*)

jaws of the wrench, but it also ruins the jaws on the end where the pounding is done, so that the entire wrench is damaged as a result.

"Sometimes a mechanic will grind down the jaws of a wrench to fit a particular nut; thereafter it will never fit any standard nut. In order to get more leverage, he may resort to using a pipe for a lever, slipping it over the end of the wrench, or of hooking two open-end wrenches together so as to get the added leverage. A wrench is designed to withstand a certain force applied at a certain particular point on the wrench in order to get torsion of a definite amount. As soon as the leverage is increased, the capacity for producing this torsion is increased, whereas the wrench is still the same old wrench and cannot stand that much. If the wrench happens to have hard metal in the jaws, the result is, of course, a broken

Pushing heavily on a wood bit is unnecessary and often bends the shank

wrench. If the metal happens to be soft, then we have a spread that looks like a V.

"Then there is another one of our much abused friends—the screwdriver. I have seen more than one man pry open a box or a crate with a screwdriver. You've probably seen it done, too. First he tries to pry underneath the board and finding that it does not work, he takes a hammer and drives the screwdriver between the boards. Of course, the handle does not *always* break, and he may not have succeeded in damaging the tool at the first blow. Then he sits upon it, or at least he presses down with his entire weight. There are few screwdrivers that will not bend under these abuses, for the screwdriver is a torsion instrument and is not to be used as a lever.

"Even in using a screwdriver for the purpose for which it was made—to put in and take out screws—a number of abuses occur. When a screw is rusted so tightly in place that not enough torsion can be put upon the tool with the hand, a favorite stunt is to use a wrench or a pair of pliers. A screwdriver that will not fail under about 150 inch pounds of torsion is a pretty good one. I assure you that it does not take very much pressure to exceed this, when you use a wrench or a pair of pliers. The result is, of course, a shank twisted beyond the elastic limit or a bent

(*Continued on page 121*)

Your Tools and Their Care

(*Continued from page 120*)

blade, provided the screw head itself does not fail first. A few taps on the screw head often assist greatly in loosening a screw.

"When the point of a screwdriver is too hard, even the best of care may not prevent its snapping. Grind it up immediately, being careful, as in grinding cutting tools, not to draw the temper. Also, the screwdriver should have a relatively blunt point. It may seem rather ridiculous that I should mention it, but you would be surprised if you knew the number of 'cutting edged' screwdrivers in use today. Grind the sides straight and parallel for about ⅛ in. and let them taper back after that.

"If the handle becomes loose and is not 'built into the tool,' grind down the shank of the tool so that it has flat faces similar to a file shank. Then drive it into place and fill the crevices with hot rosin."

Prentiss now launched his last attack against the Gibraltar of our inexperience.

"Take a saw—do you know how to care for one? I don't mean sharpen it, for I'll admit that is an art that can be mastered only after many trials and even more errors. I mean ordinary care.

"THERE are many ways in which a saw can be damaged. One of these is to use too great a pressure in an effort to make it saw faster. Especially is this true in starting a cut, for pressure will cause the saw to move away from the line; then, in forcing the saw back on the line, you will cause a sort of kink in the blade and the chances are it will cross the line to the other side. In that way, it will zigzag back and forth rather than cut straight. Allow the saw to do the cutting by its own weight until the blade is laterally supported by the saw cut. Thereafter a little more pressure can be applied to cause the saw to work faster.

"Keep a saw sharp by all means, for the tendency is to ride a dull saw more than a sharp one. It does not take a great deal of buckling to give a saw a permanent set; even though it may be slight, it will grow with use.

"After completing a job, a coat of thin oil should be spread over the entire blade, because rust is a tireless and remorseless enemy of tools. I once loaned my pet saw to a neighbor. He returned it a week later, covered with rust. I questioned my wife and she informed me that the neighbor's wife had used it to saw a ham bone. That explained it. The salt had eaten into the blade and even had attacked the teeth. No amount of emery cloth could restore the saw. It was done for.

"There is only one rule for a mechanic—buy good tools and treat them well! It is cheaper, your efforts turn out better, and you get much more pleasure out of your work."

AMONG the Home Workshop features scheduled for early publication are: "How to Make Craftsman Dinner Gongs," by J. T. Garver; "Stenciling Woodwork with Sunlight," by Ernest Bade, Ph D; "The Secrets of Successful Upholstery," by William T. Weld, and "Automatic Fire-Alarm Signals," by L. B. Robbins.

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Farm Lighting Plant Furnishes Current for Radio Set

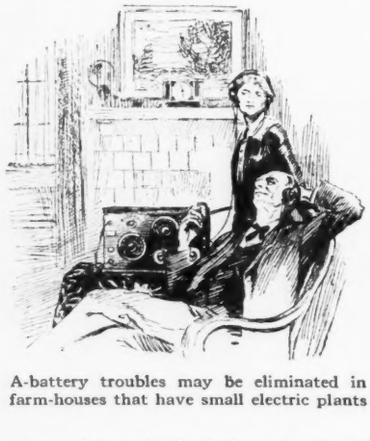
By H. Leslie Curtis

THERE is an interesting field of experiment open to those rural dwellers who possess the happy combination of a radio set and a farm electric plant. Under certain conditions the two may be combined in such a way as to eliminate the A-battery nuisance.

My own radio set is supplied with filament current from the electric plant and gives as good results as I ever attained through the use of a storage A battery, even when using a soft tube that is considered very sensitive to changes in filament current.

The set, however, cannot be used while the generator is running. Therefore you can use only a direct-current plant equipped with storage batteries. It would not be economical to use a plant of more than 32 volts. Any considerable change in the load on the lighting plant probably will necessitate a readjustment of the filament rheostat or the regeneration control. A motor running would be apt to cause unpleasant noises in the head phones.

Probably you also will find it necessary to use a hook-up in which the filament circuit has a metallic connection with



A-battery troubles may be eliminated in farm-houses that have small electric plants

the ground terminal of the set. By this I mean that there must be no condenser or other gap in series with the ground that would break the metallic connection between these points. Otherwise the counterpoise effect of the house wiring system, which is sure to be present, even if the wires are not accidentally grounded at some point, might weaken seriously the signals.

The single-tube hook-up presented by Joseph Calcaterra in the January, 1924, issue of POPULAR SCIENCE MONTHLY fulfils these conditions and gives excellent results when used in this way. With it I have heard KGO at Oakland, Calif., twice in three days. From central New Hampshire, where I live, to California is all that could be desired of one tube. Of course, this is by no means an every-day occurrence.

You must use some sort of resistance to reduce the voltage of the lighting system and protect the tube. I use a lamp bank, but a coil of resistance wire or a carbon-pile rheostat would be better. The amount of resistance necessary de-

(*Continued on page 123*)

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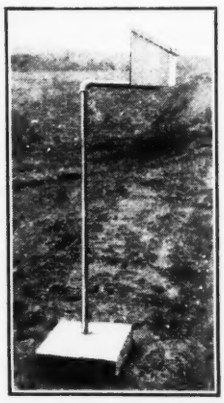
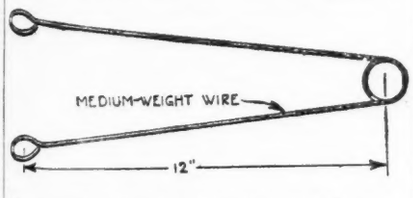


The mailbox has a heavy concrete base

The cement base is 16 in. square and 4 in. thick, cast in a form of four 1 by 4 in. boards held together with three hinges and a hasp and staple. The lower end of the pipe standard is split with a hacksaw and spread out to form a key in the cement. The box is fastened to the split end of a shorter length of pipe, which is attached to the upright with an elbow.—DALE R. VAN HORN.

Wire Egg-Lifting Tongs

LIFTING eggs from boiling water is not difficult if wire tongs are at hand. Each end of a 28-in. piece of wire is bent to form a loop about 1 in. in diameter.



The wire is then bent in the middle, two turns being made about a small stick to form a spring.—L. R. BUTCHER.

Farm Lighting Plant

(*Continued from page 122*)

pends on the number and kind of tubes used, and on the voltage of the lighting plant. If you use a lamp bank, remember that the resistance of a lamp is much less when cold than when heated. Therefore arrange a switch to short-circuit the tubes until the lamp filaments are hot. Failure to do this may mean a ruined tube.

Always use a test lamp of the same voltage as your tube in place of the tube when experimenting. Also keep an eye on the meter of the electric plant and see that no more current flows than is being used by the tubes. If one wire of the lighting system is grounded somewhere and you ground the other through the radio, enough current may flow to waste to discharge the batteries or do other damage.

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"AND he's worth every cent of it. Came here several years ago asking for a job. He got just that—a small job at a small salary.

"Then I forgot about him—hardly knew he was on the payroll until one day I got a letter from the International Correspondence Schools telling me that he had enrolled for a course of home study. It was remarkable the way he went ahead.

"We pay him $100 a week now and he's going to be earning even a larger salary some day. I wish we had more men like him."

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☐ Gas Engine Operating	☐ Chemistry ☐ Pharmacy
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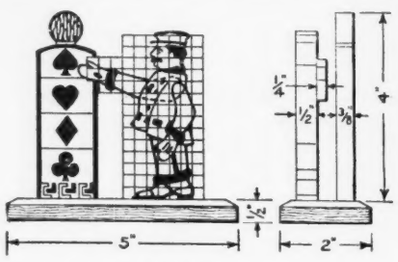
Traffic Policeman Signals the Suit that Is Trumps

AN ODD and convenient little indicator for reminding card-players of the suit that is trumps is shown in the accompanying illustration. A touch of a pencil will move the arm to indicate the proper trump. "No trump" is indicated by placing the arm in a vertical position.

The base is ½ by 2 by 5 in. with a bevel running around the top edge. The signal tower is ⅜-in. material cut with a coping-saw. The figure is laid out on ½-in. stock by means of squares. Each square in the



Front and side views of a novel home-made indicator for the card-table

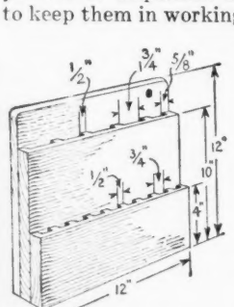
illustration represents ¼ in. The figure is then cut out with a coping-saw.

The arm is ¼ in. thick and shaped as shown by the dotted lines. After the arm has been cut out, it is fastened in the proper position rather tightly by a nail or screw. The tower and policeman are attached to the base by nails driven up through the bottom.

An attractive color scheme is obtained as follows: Paint the base black and the bevel red. The figure should have a blue uniform with black trimming, and white gloves. Shoes, of course, should be black. The tower first is painted cream color; then the edges and base border are painted black. The club and spade designs should be black; and the diamonds and hearts red. The globe should be green with the cream showing in vertical streaks, as indicated.—KENNETH R. LAVOY.

Pantry Rack for Knives

DULL knives usually result when all are thrown together in a pantry knife-box. They are a source of annoyance to the hurried housewife and to the patient or impatient husband who tries to keep them in working condition.



How the rack is constructed

Better than a box is the double deck wall rack illustrated. The back piece is ¼ in. thick, the first and second panels are ½ in.

The knife slots either can be grooved in the panels or ¼-by-½-in. strips can be nailed or glued on back of the panels to form openings. In the latter case, all the panels can be ¼-in. stock. Let the slots extend the full height to allow any material adhering to the blades to drop down. —DONALD D. SIMONDS, Worcester, Mass.

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Page 12 of Our Watch Book Is of Special Interest to You

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Sky Sports of Tomorrow

(Continued from page 27)

The Vedette lifts, in all, a total of 2944 pounds, of which 794 pounds can be used for passengers and baggage. It is just right for a week-end cruise or a picnic. An *air yacht*, so to speak. Some idea of its size may be obtained from its capacity of 141,280 cubic feet, against 5,000,000 cubic feet, which is the figure for some of the large military dirigibles that have been designed. Its length is but 190 feet; diameter 39 feet.

Thus we have actually in existence an air yacht capable of stowage in a garage of convenient size and fully able to meander down the bay on a holiday afternoon or to carry the owner and his sporting friends into the trackless wilderness after big game. Its speed of 50 miles an hour lends itself to sporting possibilities in the class of amateur contests.

NOW let the two paths of air sport converge and see how bright the almost immediate future looks. From balloon jumping and swimming, athletes can evolve games analogous to football and baseball. Instead of ground rules we shall have sky rules. Bright-hued smoke signals will lend color to the scene.

Certainly there will be developed some form of paddle attached to the player's hands or forearm to enable him to make appreciable speed. This suggests also that the form of a supporting balloon may be streamlined. And, further, that the style of "air stroke" may be something more graceful and more effective than either the crawl or the trudgeon.

An individual motor-propelled balloon of this sort always has been a great medium for the cartoonist's pen. As a matter of fact, it is very doubtful whether that convenience in vehicles is near at hand. Too many unhappy possibilities loom up when we think what motor trouble would mean. There is, however, a great opening along the line of a sort of "aerial surfboard." Study of the principles of heavier-than-air gliders surely would lead to using those same vagrant air currents as leisurely agents for dirigible propulsion.

Gliding and soaring already have come into their own abroad. But such engineless contraptions always will be too dangerous for the general public.

THESE new air sports with small balloons will be cheap. Quantity production will put them within the reach of every flivver owner.

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So before long we won't have to crane our necks to watch the big events of the sport world. In our air yachts we shall be up in the sky where the games are staged. And even if we are on the ground we shall be able to see games played aloft better than we now see games on earth from the grandstand. And when we feel the need of a bit of exercise we shall simply strap on our air preservers and loll in the clear depths of the blue sky.

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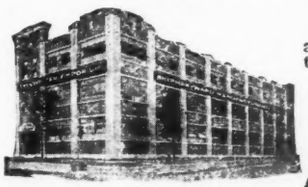

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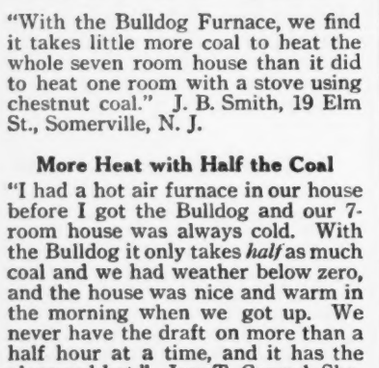
"With the Bulldog Furnace, we find it takes little more coal to heat the whole seven room house than it did to heat one room with a stove using chestnut coal." J. B. Smith, 19 Elm St., Somerville, N. J.

More Heat with Half the Coal

"I had a hot air furnace in our house before I got the Bulldog and our 7-room house was always cold. With the Bulldog it only takes *half* as much coal and we had weather below zero, and the house was nice and warm in the morning when we got up. We never have the draft on more than a half hour at a time, and it has the place red hot." Jess T. Conrad, Shamokin, Pa.



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The Bulldog is sent you for *free* inspection. Then, if satisfied, you make only small monthly payments, at our amazingly low price! Factory connections in both East and West. We ship from nearest point. Don't consider buying any furnace until you find out about the Bulldog. Write at once for our special offer and our free catalog together with the wonderful record of Bulldog success. Get ready for winter NOW! Mail this coupon TODAY!

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Without obligating me in any way please send me your free catalog and special offer on the Bulldog Pipeless Furnace.

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What Paint Means in Your Life

(*Continued from page 30*)

Mr. Gardner told me of researches that have given the industry special paints that dry with astonishing rapidity.

"It is probable that new forms of the spray machine will work extraordinary changes in our whole painting scheme," he resumed. "Today in some localities the consumer is asked an exorbitant rate for a painter with the hand brush. So nearly prohibitive is this cost that in country districts farmers and house-owners generally have let their buildings deteriorate.

"AS USUALLY happens when a need shows itself, science came to the rescue with a portable spraying machine, mounted on a motor truck. It is said that some 300 community painting machines now operate in the country districts of the West, mostly on farm buildings. The rapid growth of this method seems certain.

"I know this will not work disaster to painters. On the contrary, spray painting will enormously increase the use of paints and, correspondingly, the field of the painter—just as the sewing-machine enlarged the demand for factory garments.

"Experiments show that one of these portable spray machines operated by one man upon large areas of unbroken surfaces will do the work of four or five painters, although the paint consumed is about one-tenth more than that used by the hand brush. There is practically no difference in the appearance of the work."

Experiments to discover the effect of paint colors on temperature, health, growth, sound, and light have produced interesting results.

"Tests were made to ascertain what effect the color of a steam radiator might have on its heating capacity," Mr. Gardner told me, "and a difference of 20 per cent was found between white painted and unpainted iron radiators; the white giving the greatest radiation. Between these two, the following colors, in the order given, showed more or less difference in radiation: Cream, red, green, yellow, black, aluminum and brown.

"SIMILAR experiments were made with colored paints on small metal tanks of naphtha. Temperature readings were taken after exposure of the tanks for two hours to the sunshine. Those painted black showed the highest. Next in order came bright red, dark red, dark green, battleship gray, tan, cream, pale blue, and white. There was a total difference of 11 degrees in favor of the white. This meant that the darker colors caused greater loss of naphtha through volatilization. With black, the loss was nine per cent; with white, only four per cent.

"Work on aluminum paints has indicated their value in cutting down the ultra-violet rays of light. Application of the principle was made in coating the surfaces of balloons and airplane wings to prevent the rotting of the cloth fabric and to minimize the temperature effects upon the gas cells.

"Research in connection with paint vapors demonstrated the disinfectant quality of paint. Vapors of the drying oil in paint were found to contain formaldehyde, and therefore it is used in hospitals and homes in place of chemical disinfectants.

"Another series of tests had reference to the effect of paint colors on human growth. Rabbits were placed in large boxes, painted in different colors. It appeared that light colors of high reflection value were most favorable to rapid growth, while colors of low luminosity exerted a retarding influence.

"The effect of colors on the growth of plant life also has been tested. Potted belladonna seedlings were placed under porous paper cones of sufficient height and width to prevent interference with growth. The interiors of the cones were painted white, red, orange, yellow, green, black, and purple-tone blue. In three days evidence of plant fatigue became apparent under the blue. The leaves bleached to light yellow, and one broke from the stem. Under the green there was some yellowing, though the plants were in good physical condition. Each color had some effect. Application might be made in the coloring of special plant breeding boxes.

"INVESTIGATION of the effect of paint on sound yielded unexpected results. In a certain church acoustics were very bad; echoes were everywhere. After several coats of a stippled paint had been applied to the walls, there was material improvement.

"In another case, diners at a certain country club were annoyed by the babel of voices. Ceiling and walls were given two additional heavily stippled coats of paint, and the change was marked. Again, when the walls and ceiling of an auditorium were changed from smooth plaster to a rough finish, reverberations were much reduced.

"A test was made to discover what difference there might be in the effect of wall finishes on sound. With a plain metal wall, sound carries 40 inches; when the metal wall was coated with a sand finish, 19 inches; with a sponge-finish paint, 18 inches, and with paint in cork finish, 14 inches.

"THE possibility of having walls so painted that they yield by reflection 85 per cent of normal light is important. Experiments showed that in a certain room painted with ordinary white, four 100-watt lamps were necessary for illumination. Through the application of a non-yellowing paint only three 100-watt lamps were required. Paint substances have been found that stay white and keep their reflection value. The difference between well-painted white ceilings and ordinary light buff, for instance, may increase illumination from 20 to 30 per cent where semi-direct or similar lighting systems are used.

"Studies are now under way to prevent the fouling of vessels. Thousands of chemical and biological experiments have laid bare the habits of marine animals. Barnacles live only in the harbors—they do not venture beyond the 'three-mile limit' except as passengers on ship hulls.

(*Continued on page 127*)

What Paint Means to You

(*Continued from page 126*)

"In these experiments thousands of metal panels were coated with paints of different formulas and submerged in harbors for varying periods. The formulas showing the least fouling were retained for further experiment, and through this process have been evolved paints that solve the problem to a great extent.

"This study told us many things. The young organisms reacted to various stimuli—such as light, color, and chemical substances—in different ways. In some experiments with anti-fouling paints the barnacles reacted negatively. Again, they were so injured that they lost the power of reproduction or died and dropped off.

"ONE experiment was made with a deadly chemical substance developed during the war. Through some curious contradiction of nature, barnacles waxed fat on paint containing this acid. Something like 300 different poisons have been tried in our tests. Dark hues usually revealed a tremendous fouling of the metal with barnacles and other sea creatures, while colors of high luminosity showed comparatively little.

"A study of color preference of the lower forms of animals also has yielded information of practical value. Certain species of crustaceans showed a marked preference for colors of low luminosity.

"Other fruitful experiments have been made in the development of protective coatings for wooden underwater structures. One of the most destructive creatures of American harbors is the toredo—an animal that delights in honeycombing a wharf foundation.

"Fire-retardent paints," Mr. Gardner told me, "have been evolved through repeated tests."

A full recital of paint achievements would include almost a catalogue of paints and varnishes—for innumerable specific uses. You hardly can find any surface for which a paint or varnish has not been specially devised.

DIFFERENT woods and metals call for different technique in painting, and perhaps require special paints. Or different conditions in the same wood may indicate some particular treatment.

In paint and varnish terminology you find such expressions as chalking, peeling, scaling, flaking, alligatoring, livering, and flouring. For all these and many other ailments cures have been sought with chemistry and kindred sciences. New uses and new paints are constantly coming out of the crucible.

THIS is the first of a series of articles by Mr. Woolley on what science is doing for industry. Every move science makes, every betterment it brings about in industry, has a definite bearing on *your* welfare. In this fascinating series Mr. Woolley will point out, one by one, the steps that science has taken in your interest. In his next article he will relate how science has taken hold of the automobile industry to make your car safer, more efficient, and comfortable for you.

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Stop dieting and starving yourself—stop tiresome, monotonous, fatiguing exercise—stop paying money to expensive masseurs. By means of a wonderful new scientific, self-massaging belt you can make your waist thinner AT ONCE. Send coupon below for full particulars.

NO need now for any man to carry around a large, protruding abdomen. Not only does it mar your appearance—not only does it make you look years older than you really are—but it actually impairs your health, and thus ruins your chance for success and happiness.

Through a wonderful new invention, thousands of men have found the one safe, easy and pleasant way to get rid of the excess flesh around their waist. They don't need to starve themselves or go on a diet of any kind—they don't have to take strenuous, heart-straining exercise—and they don't have to pay the exorbitant fees charged by a professional masseur. Yet they daily get thinner and thinner—they look years younger—and they actually improve in health too!

The Secret Explained

This amazing new discovery is a remarkable new kind of a belt, which actually takes off fat in an easy, gentle way. Yet results are remarkably rapid! The moment you put on this new self-massaging belt you feel like a new person! Your waist is instantly reduced about 4 to 6 inches—your chest expands—your head and shoulders go back—your carriage becomes firmly erect. And what is even of greater importance, after a few weeks results become permanent!

The Weil Scientific Reducing Belt, as the new invention is called, is the result of years of careful experimentation and research by experts. It is made of specially prepared and scientifically fitted rubber, and is so constructed that it provides a constant gentle massage to the abdomen. Every time you move—every time you even breathe—a certain amount of fat is massaged away, and before you know it your girth becomes inches smaller! In many cases reductions of as much as 8 inches have been noted within a few weeks!

And with this rapid reduction of the waist a wonderful improvement in health is immediately noted. Stomach disorders—backache—constipation—shortness of breath—all vanish, as the sagging internal organs are once more brought back to their normal positions.

10 DAYS' TRIAL SEND NO MONEY

We don't want a single penny unless the Weil Scientific Belt convinces you that it will quickly and easily help you to reduce your waist just as it has thousands of others. So we are willing to let you try the belt for 10 days at our risk.

Simply send the coupon below and full particulars will come by return mail. If you write at once, you can also get in on our new Special Reduced Price Offer being made for a limited time. Mail coupon TODAY to **The Weil Company, 109 Hill Street, New Haven, Conn.**

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Gentlemen: Please send me, without obligation, complete description of the Weil Scientific Reducing Belt and also your Special 10-day Reduced Price Offer.

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How to judge tobacco

The true test lies inside the pipe—not in the pedigree, says Mr. Krob

In the following letter Mr. Krob points out that once we are past the infantile stage of "taking the watch apart to see what makes it run," we learn that true happiness is a matter of appreciation rather than of analysis. How do you feel about it?

Lorain, Ohio

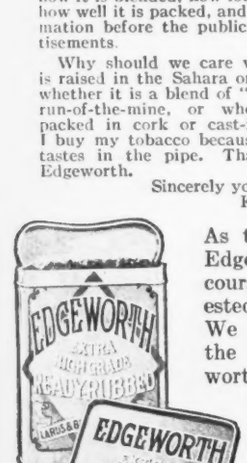
Larus & Brother Company,
Richmond, Va.
Gentlemen:

Most people who are buying Better Light look up at the fixtures we install and say, "That's wonderful," when they should not even be interested in the fixtures. They should look down at their desk-top or counter or work-bench, where they actually use the light. They always want to consider it "F.O.B." the lighting fixture, instead of "Delivered" to the working plane, where it is to be utilized.

Personally, that's the way I look at tobacco. Many manufacturers go into detail telling us where their product is raised, how it is blended, how long it is aged and how well it is packed, and place this information before the public in their advertisements.

Why should we care whether tobacco is raised in the Sahara or on an iceberg, whether it is a blend of "57 Varieties" or run-of-the-mine, or whether it comes packed in cork or cast-iron containers? I buy my tobacco because of the way it tastes in the pipe. That's why I use Edgeworth.

Sincerely yours,
K. M. Krob.



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Wonders of the Sea

(*Continued from page 37*)

the United States, the Middle Atlantic coast, further removed from the influence of the Gulf Stream, knows variable temperatures and cold winters.

An equally remarkable phenomenon is the Sargasso Sea in the center of the North Atlantic. This is an area of still water several hundred thousand square miles in extent, filled with a seaweed called sargassum, known also as the gulf weed. This weed is believed to grow on the distant shores and to be carried to the Sargasso Sea by ocean rivers such as the Gulf Stream. There are at least four other similar, though smaller, bodies of still water in the Pacific and Indian oceans.

This probably will suffice to give a superficial picture of the physical characteristics of the sea. The real wonders of the sea are far beneath its depths, for the sea contains much more life, both animal and vegetable, than is present elsewhere on the globe. These specimens of marine dwellers are of exotic forms and colorings and of weird physical characteristics such as are possessed by no animal or plant of the land and no bird of the air.

STRANGELY enough, though, the queer denizens of the deep are believed by scientists to possess a kinship with the animals of the land, even including man. Chemical analysis of sea water shows that in the salts it contains it is remarkably similar in composition to human blood. From this fact the theory has been advanced that all life had its origin in the sea; that the salt water which the early sea dwellers carried in their bodies when they took to the land has been passed along as blood from generation to generation through all the evolutionary changes that have taken place to produce the higher forms of life.

This, however—assuming that the theory is correct—is about the only relic that man and the other animals of the land have taken from the sea, for none of them has the physical capability of supporting life beneath the surface of the ocean. It is not so much a matter of obtaining air to breathe, for science might supply the means of obtaining that. Divers have descended 200 feet and more into the sea. That they cannot descend further is due to the enormous pressure of the water, caused by its weight. If you have ever tried to "fetch bottom" when diving into a lake or river, you undoubtedly have experienced the effect of that pressure in a slight degree. Your ears have rung; there has seemed to be a crushing weight pressing on your head and chest.

NOW, the painful, crushing pressure that would be felt 20 feet or so beneath the surface of a shallow inland stream of course is multiplied immensely at the bottom of the sea. Science has calculated the average pressure at the ocean basin to be about 2½ tons to the square inch. In the deeps it is five tons or more to the inch. The effect of that enormous pressure has been demonstrated by many

(*Continued on page 129*)

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Wonders of the Sea

(Continued from page 128)

interesting experiments performed by oceanographers.

If you were to take an empty bottle, cork it, affix a weight to it and let it down into the sea depths on a line, what do you think would happen to the bottle? When you pulled it up again, you would find the cork driven in by the ocean pressure and the bottle filled with water. If you were to repeat the experiment with a hollow glass ball, this would be crushed, or the pressure of the sea would force water into the globe through imperceptible imperfections in the glass. A block of wood, weighted so that it would sink, then drawn to the surface again, would no longer float after you removed the weight, for the ocean pressure would have forced water into the cavities of the wood, causing the block to become thoroughly water-logged.

ONCE on an oceanographic voyage, a scientist wrapped a sealed glass tube in cloth, placed it within a copper cylinder, weighted the apparatus, attached a line and threw it overboard. When it was drawn up again, the cylinder was crushed almost flat, as though pounded with a hammer, and all that was left of the glass tube was a small quantity of powder!

Any watertight vessel thrown into the ocean, reaching a depth where the pressure is too great to be resisted by the material of which it is composed will give way by what is called "implosion," a bursting inward, the opposite of explosion, which is a bursting outward. Even a fish of the upper strata of the sea, descending below its accustomed pressure level, would be killed by implosion. On the other hand, a fish from the bottom, constituted to live in a region of great pressure, actually would explode, if it should swim too close to the surface, due to the expansion of the gases in its internal organs from the reduced pressure.

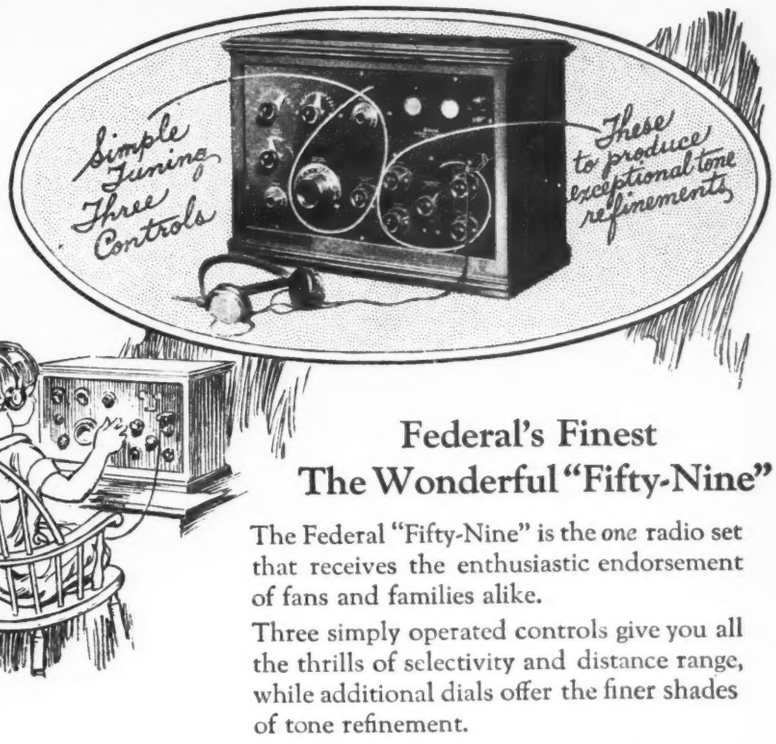
That there can be animal life in the deep-sea areas of enormous pressure is due to the fact that the bodies of the creatures inhabiting them are porous and so thoroughly filled with water that the great pressure is not felt.

MANY of the deep-sea animals resemble plants in their structure; they are exquisitely formed, and delicately colored. Their bodies consist of slim, graceful "stems" surmounted by objects that seem to be full-blooming flowers. But these forms of life are not plants, but animals; for there is no vegetation at all in the depths of the sea.

Then there are crustaceans and spider-like creatures innumerable, and amazing fish that seem to consist mostly of eyes and mouths. All of these creatures may be said to live solely by eating one another, for the quantity of food that falls to them from above in the form of carcasses of upper-sea animals is small. This explains the huge mouths and sharp teeth of the deep-sea fishes; few opportunities to feed come to them, so they must get all the food possible when chance presents.

Nature has further aided them in solving the problem of existence by pro-

(Continued on page 130)



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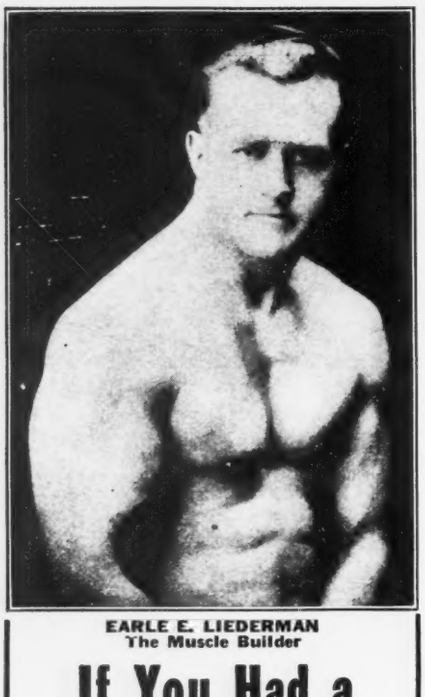

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you would try to change it. But just because you wear a pair of pants and a coat to cover the rest of your body you don't seem to care a rap what you look like from the neck down. Come on out of it fellows. Get wise. Don't you know you can't keep this up? It's only a few years and ZOWIE it's too late. Your body is clogging up with all kinds of poisons. The only way to get rid of these poisons is to drive them out. Exercise wears off the worthless tissue, the blood carries it to the surface and then you sweat it out through your pores. That's simple enough. But if you don't — your blood will absorb all this poison and soon you're nothing but a human wreck.

I MAKE STRONG MEN

No one likes to look at a narrow-shouldered, flat-chested dyspeptic. Such a man is no good to himself or anyone else. It's the strong, robust, energetic man who gets ahead. He is admired and sought after in both the business and social world. No matter where you find such a man, he is the whole works.

Come on then—snap into it. Right now—this minute. This is your day. This message was meant for you or you wouldn't be reading it. I'm all set and waiting for you, and oh boy! what I do to you will sure open your eyes. I'm going to push out that chest of yours, broaden your shoulders, and put a pair of arms on you that will carry the kick of a mule. I'm going to build up your whole body with good, solid muscle. I'm going to strengthen every vital organ and shoot a quiver up your old spine that will make you feel like a jack rabbit.

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Just because a man is built like an ox doesn't mean he can show you how to be the same way. There are plenty of strong men today who couldn't tell you how they ever did it. I made my reputation teaching and building others. And my biggest achievements have been made during the past year—not ten years ago. My instructions are modern and up-to-date. When you come to me your success is assured. I don't promise strength—I guarantee it. Are you ready? Let's go.

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Wonders of the Sea

(Continued from page 129)

viding them with highly elastic bodies. This permits them often to swallow creatures almost of their own size. Their eyes may seem a useless gift, since they live in a region where no sunlight can penetrate. It happens, though, that some of them carry their own headlights, for they produce phosphorescent light that probably suffices to illuminate their prey. Their luminescent glow, of course, probably makes them visible to other preying creatures, and this results in their destruction; but thus Nature contrives to maintain a balance even in the sea.

The vast majority of the deep-sea creatures, however, are sightless — at least that is indicated by the specimens that have been scooped up by scientists. They find their food by means of their antennae or "feelers," or through some senses akin to feeling or smell.

PROBABLY you are familiar with the animal life of the upper waters of the sea. There are mammals, such as whales, seal, and walruses, and—fish. The latter exist in almost infinite variety. It would be futile to attempt to describe even a few.

Along the shores are other forms of sea life—the clams, oysters, crabs, lobsters, mussels, and shrimps we use for food; the worms, starfish, sea urchins, and sponges; the corals, the sea-anemones. All of these, no matter what their form, are animals.

The vegetation of the sea consists entirely of the great floating meadows of seaweed, the grass that grows near the shores, the moss that covers the rocks. This, though, plays an important part in the great scheme of the sea, supplying food for some of the sea animals and liberating oxygen into the water so that the crustaceans and fishes may live.

Once, of course, there was no sea. When our earth was formed, the hydrogen and oxygen, the combination of which forms water, were held in its hot crust. As the earth cooled, the hydrogen and oxygen were liberated, combining into water, and the water filled up the great hollows in the earth's surface.

SO CAME the sea to help make the earth more livable for man who was yet to come. For the sea helps distribute the heat of the sun, yet by the circulation of the icy waters of the polar regions prevents the sun from baking the earth.

It aids agriculture and purifies the air we breathe by the admirable cycle through which its waters pass in their evaporation, and later precipitation as rain.

It distributes the dust of the earth, for it is the beginning and end of all streams that pass through the land.

It yields man a rich harvest in food, and unites the distant dwelling places of the different races of men.

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How Chemistry Is Feeding Us

(*Continued from page 45*)

Dehydration of fruits and vegetables—the removal of nearly all moisture with the least damage to the product—has made rapid advances, but here improvements are still needed and are coming along. The goal is to produce dried fruits and vegetables, which, after they are soaked in water, will be almost as good as when fresh.

The bread bakers, too, have a great institute of research in Chicago, besides private laboratories and fellowships at the Mellon Institute and elsewhere. Their purpose is to make bread a more complete ration so that we, the general public, may find ourselves more satisfied with this cheapest of foods, and consequently will eat more bread and less meat.

The improved bread uses up the summer milk of the dairy farmers who have been lacking a market for it heretofore. The milk is dried and worked into the bread, giving it many of the qualities for which we eat meat. There is three or four times as much milk in bread now than there was five years ago. Using more wheat by stimulating greater sales of bread, and using more milk to encourage the sales, is profitable to the farmers and economical to the consumers.

Even in the fields, science protects the crops that feed us. Insect pests may destroy a whole civilization, and the battle against them must be incessant. If it had not been for American entomologists and chemists, the fruit crops of this country would have become negligible.

IN THE study of foods, research is proceeding also along the line of maintenance of health. It has been found that unless minute quantities of certain elusive bodies called vitamines are present in food, various diseases, such as beriberi, scurvy, certain eye troubles, and probably rickets, will follow.

The chemical structure of vitamines is still unknown, although it is possible to separate them into four different kinds and to get rather concentrated aggregations of them. Three have been known for some time, and lately Dr. W. H. Eddy, of Columbia University, has found a fourth. Scurvy and beri-beri, both distressing, and formerly fatal diseases, have been practically eliminated by the discovery of the necessary vitamines in milk, green vegetables, rice husks, citrus fruits, tomatoes and other substances.

As to the requirements of the body for minerals such as lime, iron, potash, and the like, we know now at least how much of these substances should be included in a month's ration of food. It has been found that illness usually follows deficiency in one or another of these minerals. Goiter, for example, follows a deficiency in iodine in food or drinking water. Growing children with growing bones need more lime than their elders.

And so we go on, trying to do the useful things and seeking always to understand a little better than before. Science doesn't move ahead with a brass band, with trumpets and drums. No; its progress results from hard, slow work, with here and there a happy reward.

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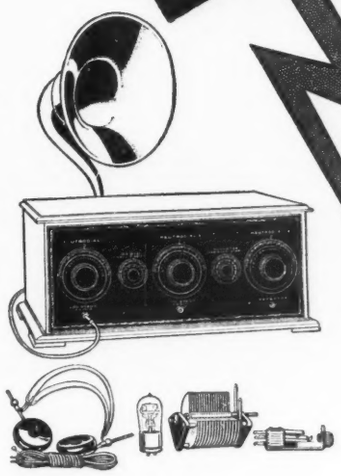

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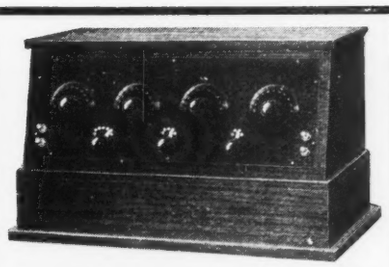

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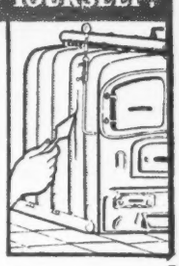

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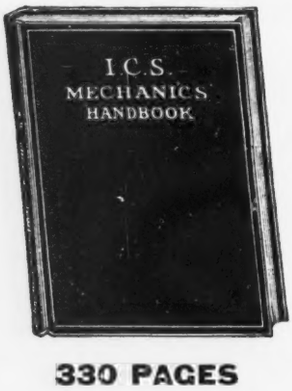

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Here Are Correct Answers to Questions on Page 64

1. Because when you go uphill you are lifting your weight against the force of gravity. This takes power. When you go down, the force of gravity is with you.

2. They are substances present in very small amounts in many foods and that seem to be necessary to health. Their exact chemical nature is not understood, nor do we know the precise way in which they act on the body. If your usual diet includes meat, milk, butter, and fresh vegetables, you will get enough vitamines.

3. When men first began to study the stars, it seemed that the stars marked out figures in the sky. The ancient Babylonian astronomers, thousands of years ago, gave names to these figures and used them as a convenient way of referring to certain stars. Later on this system was borrowed by the Persian and Arabian astronomers and came from them to us.

4. If there were any air inside the bulb, the hot tungsten in the filament would combine with the oxygen of the air and burn up.

5. Science believes that it cannot. Energy is merely changed. Electric energy in a wire may disappear as electricity, but the same amount of energy appears as heat.

6. Because he is in the habit of feeding on the leaves at the top of trees. In the course of millions of years he and his ancestors have developed a longer and longer neck so that they could reach high trees.

7. The waves of sound in the air strike against something hard and smooth, like a wall or the side of a cliff, and are reflected back again, much as light waves are reflected when they strike a mirror.

8. 5,885,516,000,000,000,000,000 tons. To get some idea of what this means, think of a tiny dust mote in a beam of sunlight and compare the weight of this with the steamer *Leviathan*. The earth is as much heavier than the *Leviathan* as the *Leviathan* is heavier than the dust mote.

9. It is a stream of electrons rushing through a wire like a stream of people in a tunnel. Through the filament of an ordinary 60-watt electric lamp there pass every second so many electrons that if all the people in New York City were set to counting them and if they counted two a second without stopping for 10,000 years, they would still have a few to count.

10. No. They are far too small. It takes more than a hundred million hydrogen atoms laid side by side to make up one inch. The other kinds of atoms are only a little larger than this.

11. Radium. It is worth nearly $2,000,000 an ounce. Of the ordinary commercial metals, iridium, the metal used for fountain-pen tips, brings the highest price, about $250 an ounce.

12. There are a great many things that happen in our nervous system of which we are conscious only indirectly. For instance, when the stomach is empty and several hours have passed since the last meal, the nerves in the stomach lining send messages to nerve centers in the spine and in the back part of the brain and announce that the digestion of the last meal has been completed and that another one can be sent along. The lower nerve centers translate this message into hunger.

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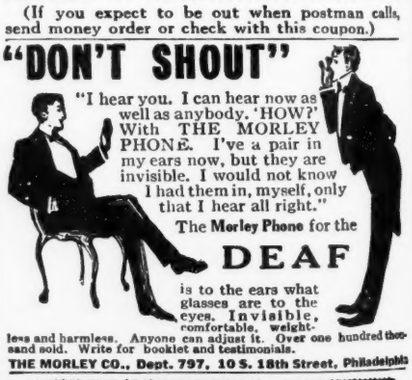

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Build a Super-Heterodyne

(*Continued from page 69*)

adjustment. The stationary plates are marked *A*, and the rotary plates, *B*.

Number 6 is the A-battery switch; No. 7 the rheostat controlling the oscillator tube, and No. 20 the rheostat controlling the first detector tube.

Number 8 is a .002 microfarad fixed condenser.

Number 9 is the negative B-battery terminal; No. 10 the oscillator tube socket, and No. 19 the first detector tube socket.

Number 11 is the honeycomb-coil mounting used when a coil is required, for use with aerial and ground. Only the terminals are shown on the rear of panel.

Number 12 is the positive B-battery terminal of the oscillator circuit. The positive B-battery connection is made through the amplifier units connected with this first unit.

NUMBER 13 is the pick-up coil through which the oscillator wave is impressed on the grid circuit of the first detector tube.

Number 14 is the grid coil, and No. 15 the plate coil of the oscillator. The terminals of each coil have been marked *A* and *B*. The *A* or inside end of each coil is the end nearer the center of the coil, while the *B* or outside end is the end farther from the center.

Number 16 is the variable condenser used to tune the aerial circuit. This condenser should be of .0005-microfarad capacity and should be provided with a Vernier adjuster. The stationary plates terminal is marked *A*, and the rotary plates terminal, *B*.

Number 17 is a .00025 microfarad grid condenser, while No. 18 is a fixed grid leak of two megohms.

Number 21 is the plate terminal, connected with the amplifier unit. From this the connection goes through the primary of the amplifier unit transformer, thence to the B battery.

Numbers 22 and 23 are terminals with which the A-battery circuits of the amplifier stages are connected.

TURN now to the two-stage audio-amplifier unit.

Terminal 24 is the input terminal of the amplifier unit; No. 25, the negative A-battery terminal; No. 26 the positive A-battery terminal of the amplifier; No. 27 the tube socket of the first audio-frequency amplifier stage; No. 37 the tube socket of the second audio-frequency amplifier stage. Numbers 28 and 29 are double-circuit jacks. Number 30 is a single-circuit jack.

Numbers 31 and 36 are audio-frequency amplifying transformers. If you use another type of transformer, follow wiring directions according to terminal marking.

Number 32 is the positive B-battery terminal for the detector stage that is connected before the first stage audio-frequency amplifier.

Number 33 is a standard 4½-volt C battery; No. 34, a one-microfarad fixed condenser; No. 35 the rheostat used to control the filament current of the two audio-frequency amplifier tubes; No. 38

(*Continued on page 134*)

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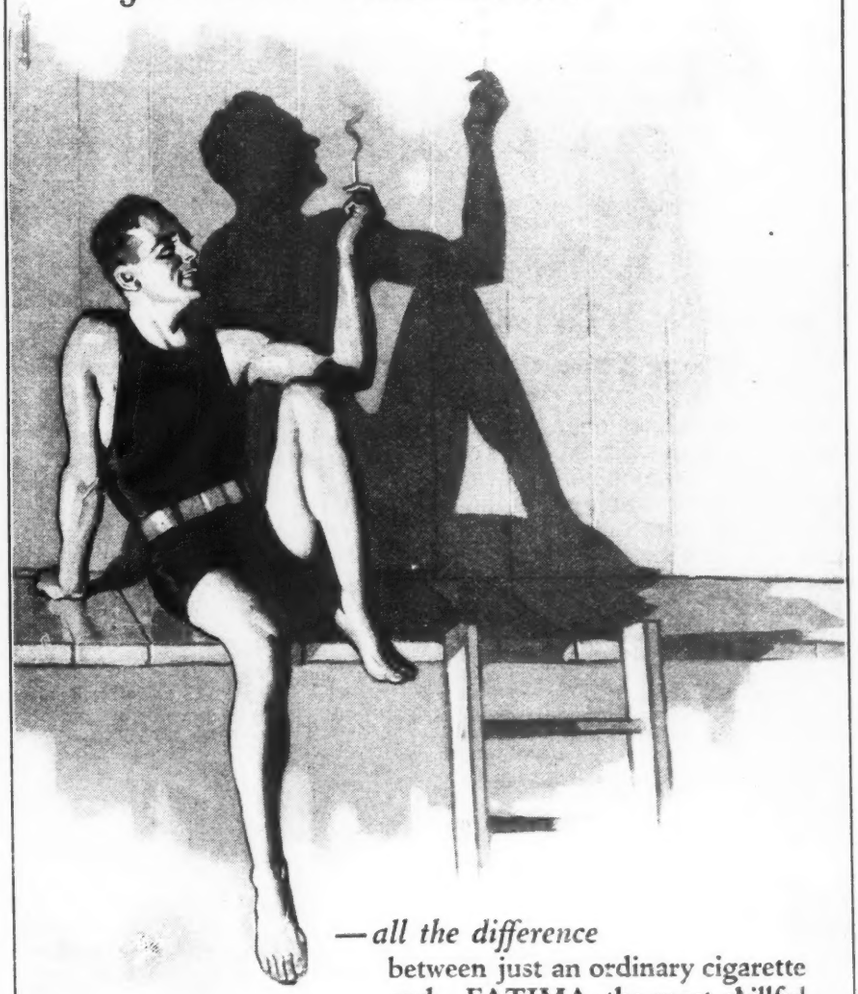

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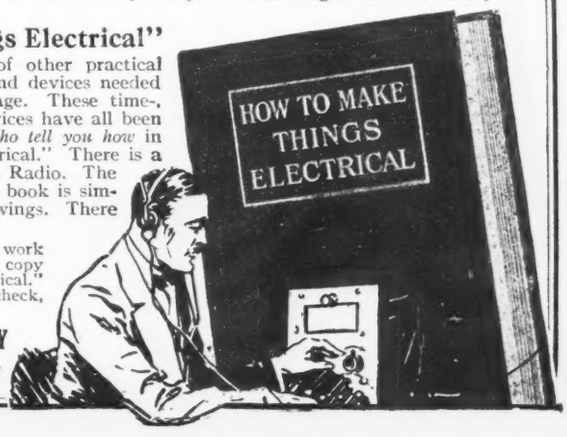

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How to Build a Super-Heterodyne

(*Continued from page 133*)

the positive B-battery terminal of the audio-frequency stages.

The wiring of the receiver is simple.

First, begin wiring the oscillator and first detector unit. Practically all leads terminate at the filament circuit, so it is best to wire the filament circuit first. Begin by connecting terminal 3 with the *A* terminal of battery switch 6. Run a wire from the *B* terminal of switch 6, connecting in turn terminal *B* of rheostat 7, terminal *B* of rheostat 20 and terminal 22.

NEXT, run a wire from terminal 4 to terminal 23 along the baseboard close to the panel. With this wire, join terminal 9, *B* terminal of fixed condenser 8, F_1 terminal of socket 10, the outside end *B* of grid coil 14, the outside end *B* of the pick-up coil 13 of the oscillator assembly, and the F_1 terminal of socket 19. The *A* terminal of rheostat 7 is connected with the F_2 terminal of socket 10, while the *A* terminal of rheostat 20 is connected with the F_2 terminal of socket 19.

Next, run a wire connecting the *P* terminal of socket 10 with the rotary plates terminal *B* of the oscillator condenser 5. The outside terminal *B* of plate coil 15 of the oscillator assembly then is connected with the wire just mentioned.

From terminal 2 run a wire along the back of the panel to a point just over the center of rheostat 20; then bend it out and terminate it at the rotary plates terminal *B* of the variable condenser 16. The *B* terminal of the coil mounting 11 and the inside terminal *A* of the pick-up coil 13 are connected with this.

The inside terminal *A* of the plate coil 15 is connected with terminal 12 and with the *A* terminal of fixed condenser 8.

The stationary plates terminal *A* of condenser 5 is connected with the *G* terminal of socket 10. The inside terminal *A* of the grid coil 14 is then joined to the wire just mentioned.

The *G* terminal of socket 19 is connected with the *B* terminal of grid condenser and leak 17 and 18.

Now run a wire connecting in turn, terminal 1, terminal *A* of the honeycomb-coil mounting, the stationary plates terminal *A* of the variable condenser 16, and the *A* terminal of grid condenser and leak 17 and 18.

The wiring of this first unit is completed by connecting the *P* terminal of socket 19 with terminal 21.

Now we are ready for the two-stage audio-frequency amplifier unit. Here, also, we can begin by wiring the filament circuits.

First run a wire from terminal 25 to the *B* terminal of rheostat 35. The positive terminal of the C battery 33 is connected with that wire. Then connect the F_1 terminals of sockets 27 and 37 and with terminal *A* of rheostat 35.

Now run a wire from terminal 26, along the back of the panel, to terminal F_2 of socket 37. To this wire are joined the F_2 terminal of socket 27 and the *A* terminal of condenser 34.

In the double-circuit jack the *A* and *D* terminals are the outside terminals or springs. The *A* terminals of all the jacks are the ones nearest the frames. The *B* terminal is the inside terminal that makes contact with the *A* terminal, while the *C* terminal is the one that makes contact with the *D* terminal.

Connect the *A* terminal of jack 28 with terminal 24; the *B* terminal of the jack with terminal *P* of transformer 31; the *C* terminal with terminal *B* of transformer 31; the *D* terminal with terminal 32.

The *G* terminal of transformer 31 is connected with the *G* terminal of socket 27; the *P* terminal of socket 27 with the *A* terminal of jack 29; the *B* terminal of the jack with the *P* terminal of transformer 36; the *C* terminal of jack 29 with the *B* terminal of transformer 36; the *D* terminal of jack 29 with the *B* terminal of jack 30, and with terminal 38.

The *G* terminal of transformer 36 then is connected with the *G* terminal of socket 37. The *F* terminals of transformers 31 and 36 then are connected with the negative terminal of C battery 33.

The wiring of the amplifier unit is completed by joining the *P* terminal of socket 37, the *B* terminal of jack 30, and the *B* terminal of condenser 34.

The completed units now are ready to be used with the intermediate frequency amplifier and second detector unit.

If you complete these two units, you can use them as a three-tube honeycomb-coil non-regenerative receiver. Simply disconnect the pick-up coil 13 from the circuit and connect the rotary plates terminal *B* of condenser 16 with the positive A-battery lead, which terminates at terminal 4. Then you can use a 25-, 35-, or 50-turn honeycomb-coil in mounting 11 to act as the tuning element.

CONNECT terminal 1 with an outside aerial, and 2 with a good ground.

Connect terminal 21 of the detector unit with terminal 24 of the amplifier unit by a wire on the front of the panel between the two binding posts attached to terminals 21 and 24. Similarly, connect terminal 22 with 25, and 23 with 26. These last connect the A-battery leads of the amplifier unit with the A-battery leads of the detector and oscillator unit.

Next, connect terminal 3 with the negative A-battery terminal, terminal 4 with the positive A-battery terminal, and terminal 9 with the negative terminal of the B battery. Since the oscillator stage is not used, terminal 12 is left unconnected.

Terminal 32 serves as the positive B-battery terminal for the detector stage, and terminal 38 as the positive B-battery terminal for the amplifier stages.

If a soft tube is used as the detector, terminal B should be connected with a B-battery voltage of not more than 22½ volts. If a hard tube is used, terminal 32 may be connected with a plate voltage as high as 67½ volts. Terminal 38 should be connected with a B-battery voltage of about 90 volts.

The voltage of the A battery will depend on the types of tubes used. The oscillator tube socket 10 is not used.

This receiver is very easy to tune, and will enable you to listen to programs until you complete the intermediate frequency amplifier and second detector unit.

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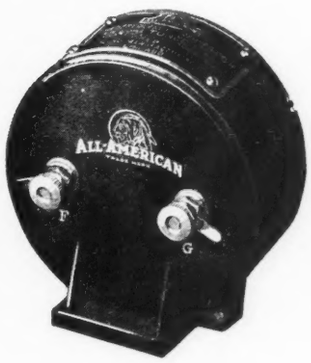

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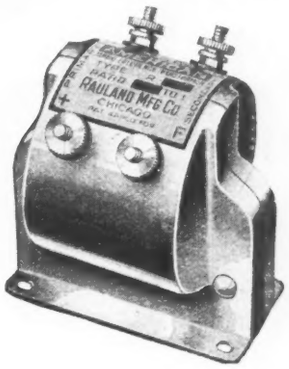

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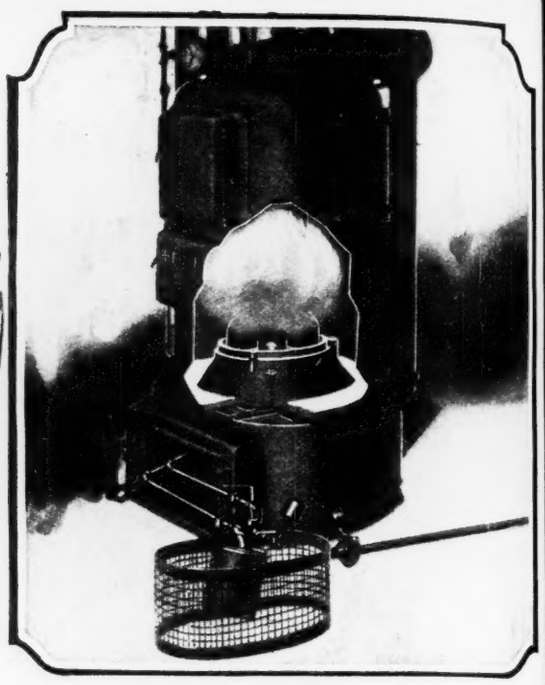

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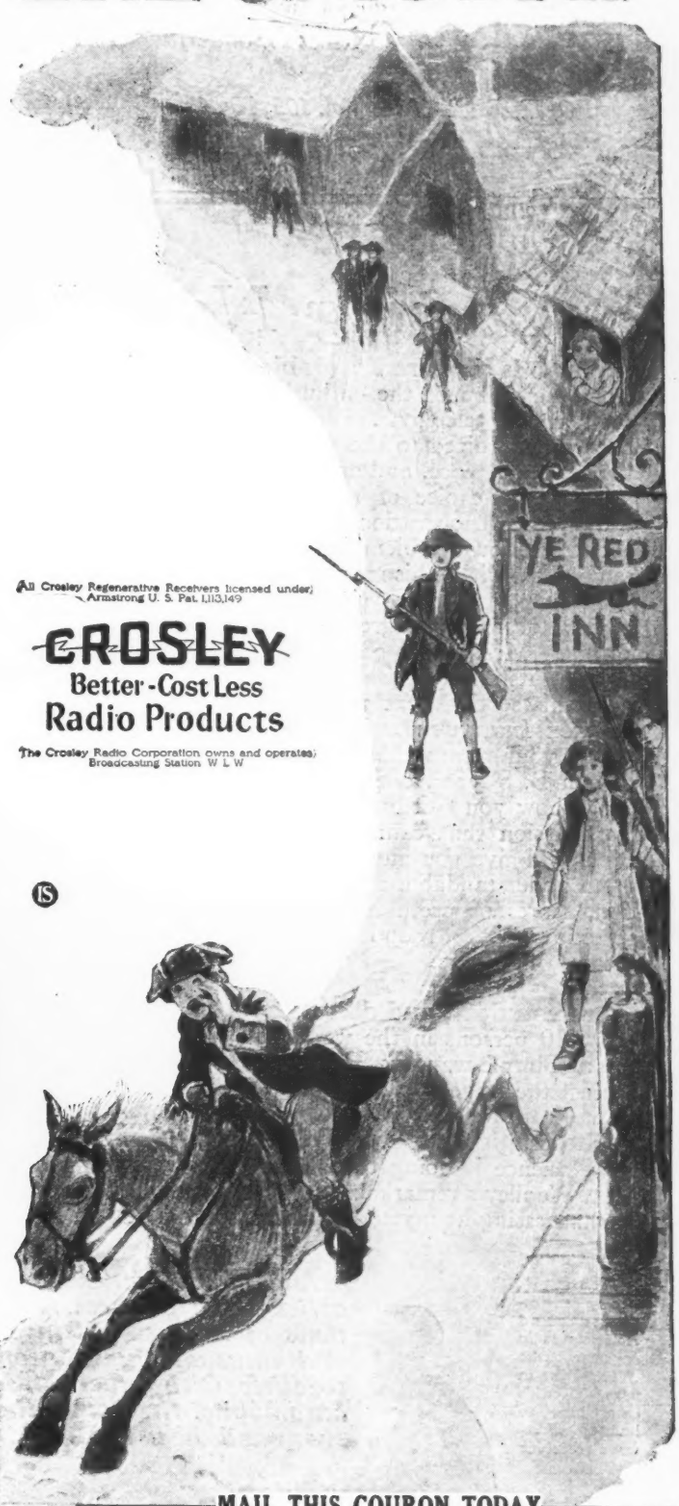

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